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MEASURING HYSTERESIS.

Mr. Frank Holden in another column describes a simple hysteresis meter which has been in successful commercial use for several years, and has given results sufficiently accurate for practical purposes. Owing to the large variations in the hysteretic qualities of iron it is desirable in the construction of electrical machinery that this factor should be definitely determined for the particular iron used, not only in order to secure the least loss of energy, but also that the heating of the armature core may be kept down, since the hysteretic energy is transformed into heat. The data given seem to demonstrate that the hysteretic exponent is not so nearly constant as was supposed, and its average value not as great as 1.6; in the experiments referred to the value of the exponent varied between 1.4 and 1.7, the average being 1.5. The method of Mr. Holden in separating the effect of eddy currents from the hysteretic losses is an ingenious one, and, as shown by the results, proved to be sufficiently accurate for any practical purpose.

ELECTRICITY ON SHIPBOARD.

The description which we print elsewhere of the electrical installation on the new American liner, the *St. Louis*, will give a partial idea of the extent to which electricity is now employed on shipboard. While its application in the present case is not so complete as it might be made, yet the great care with which every part of the plant has been designed and executed to suit the actual conditions is unusual even in ship work. It would seem, however, that advantage might have been taken of the convenience of electric motors for the handling of the cargo, and it will probably not be long before other operations aboard ship will be performed by the same means, such as steering the vessel, handling the reversing gear of the main engines and turning the capstan. The rudder electric indicating apparatus on the *St. Louis* appears to be both simple and reliable, and the electric revolution indicator is simplicity itself. It remains to be proved, however, whether the latter will continue satisfactory in service; a method very similar for indicating revolutions was tried ten years or more ago in some of the European navies and discarded, but we are not aware of the nature of the objection found, which may be eliminated in the present case.

OUTPUT OF POLYPHASE GENERATORS AND ROTARY TRANSFORMERS

In another column we print a notable article by Mr. Ralph D. Mershon, in which the factors relating to the output of polyphase generators and rotary transformers are mathematically treated and comparative deductions made. While the mathematics employed is somewhat abstruse, this is necessarily so from the nature of the subject, and as the object of the article is to establish certain principles, it would not be desirable to make any sacrifice in the interest of simplicity. Polyphased machinery is often regarded as something complex and mysterious, but the second paragraph of the article shows that as far, at least, as the windings are concerned, this view is wrong. It will be seen that the armature of any closed coil direct current machine may be simply transformed into a polyphased armature, it being merely necessary to make three or more connections corresponding to the desired number of phases, from collecting rings to the same number of commutator bars at an equal angular distance from each other. We may here remark that in one of the largest manufactories of polyphased machinery in the world, the armature cores of some types of polyphased and direct current machines are made identical, and the windings on the cylindrical surface and back end are the same, the connections in the front end of the armature only differing. Some of the deductions of the author are

rather striking, notably the one showing that by merely changing the connections of a three-phased generator and adding three additional rings the output of the machine may be increased 16 per cent. and that a similar change in the connections of a three-phased rotary transformer will produce an increase of 45 per cent. in its output. Similarly, the output of what are called "quarter-phase" generators and rotary transformers are increased 10 and 22 per cent., respectively, over corresponding three-phased machines. It very often happens, however, that the factor which fixes the output of an armature is the heating limit, and in the present instance it might occur that the calculated gain cannot therefore be practically realized, though, in any case, on account of the increased efficiency of the armature, it may be approached.

THE NIAGARA MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The general meeting of the American Institute of Electrical Engineers at Niagara the last week of the present month promises to be one of much interest, as indicated by the programme we print elsewhere. While the papers are less in number than at Philadelphia last year, they are, on the whole, more practical in character, and those relating to the Niagara plants will contain the first account of many of the electrical features of that enterprise. The selection of Niagara as the place of meeting would have been a happy one under any circumstances, and in the present instance is exceptionally appropriate on account of the date of meeting being coincident with the starting of the transmission plant which, we believe, is to be officially declared in commercial operation during the meeting of the Institute. That the attendance at Niagara will be unusually large seems probable, and perhaps the result may be to incline the opinion of members toward the choice of similar localities for future general meetings instead of holding them in large cities as in the past. A week off during June at a pleasant resort would present an attraction to many members who have never thought of attending meetings in cities, and the consequent absence of business engagements would tend to insure the undivided attention of all to the real objects of the meeting.

ARBITRARY THEORY.

Mr. Townsend Wolcott in another column attacks in a lively manner the Rückerian philosophy of units, which he considers to be founded upon a wrong conception as to the nature of dimensional formulas. Leaving the defense of the theory attacked to others who have made it a close study, we may add that in the hands of others than adepts theories such as referred to are capable of creating much misunderstanding. It is but a few years ago that resistance was constantly referred to as a velocity for the reason that its dimensional formula was identical with that of velocity, and this singular assumption doubtless discouraged many students who endeavored to discover a physical *raison d'etre* for it. About the same time the henry was spoken of as a length, the result of which was probably to prejudice many against the introduction of a unit which, from this definition, could apparently serve no earthly use. In neither case, as far as we know, was any reason advanced for calling a resistance a velocity or an inductance a length, other than the identity of dimensional formulas. Viewed physically, the former naturally brought up the cognate idea of friction, and the latter that of electromotive force, and the student could not be blamed if he became discouraged in harmonizing these conceptions with velocity and length. The fault which we refer to is not, however, confined to the realm of theory, for in practice it is only too common to lose sight of the real nature of things and give extensions to principles not warranted by their nature. Characteristics, for example, at one time were given a most undue weight, it being shown that machines could not run in parallel that did not have identical curves, and all of the principles of dynamo action were illustrated by their arbitrary manipulation. Still later the counter electromotive force of motors was looked upon as sufficiently abstract in its nature to admit of many fanciful assumptions, and even Institute papers were read to glorify this mysterious attribute of motors, and ascribe to it singular properties. Abstractions as such may perhaps be safely handled by philosophers and savants, but it is rarely safe for others to wander too far away from the physical standpoint, or to accept ideas for which they can find no physical basis.

Steam Jackets.

Prof. Unwin, in a recent lecture stated that some time ago he ventured to say there was no trustworthy engine test which showed that the consumption of steam with a jacket is greater than without a jacket. He believes that is still true, but undoubtedly the economy due to the jacket varies in different cases from 30 per cent. to very nearly zero. Roughly, the jacket is more useful with small engines than with large; with slow engines than with fast engines; but all this amounts to little more than saying that the jacket is most useful in those cases where the initial condensation is largest. Just in proportion as the engine, whatever its type, is of the highest class and most scientific design, the jacket is less useful. No one probably designed better simple engines than Corliss, and Corliss did not use jackets. In an experiment by Delafond on a large Corliss engine at Creusot, the jacket effected an economy of only 2 per cent. The same rule holds with compound engines. Hirn found an economy of 25 per cent. due to the jackets in a Woolf engine tested in 1855, but since then the compound engine has been improved, and the advantage of the jacket is less. Prof. Witz made very accurate experiments with a large compound engine of about 600 ihp, provided with jackets both to cylinders and receiver. The trials were strictly comparable, the pressures, temperature ranges, and total power developed being nearly the same. The total condensation in the jackets was 12 per cent. of the steam used, so that the jackets were not inactive. Yet the absolute saving of steam due to the jackets was only 4 per cent., or allowing for heat saved by returning the jacket drainage to the boilers, 6.6 per cent. It is perhaps probable that as the temperature range in the cylinder is diminished by compounding, the temperature gradient from the jacket to the interior of the cylinder is diminished, and the rate of transmission of heat decreased. It appears, then, that as engines are better designed, the jacket is of less use, and it is not by means of the jacket that the waste due to cylinder condensation can be got rid of, or the highest economy of which the steam engine is capable reached.

Telephone Protective Association of America.

The officers of the Telephone Protective Association of America, which was organized at Chicago on May 27, are as follows:

President, J. E. Keelyn, Western Telephone Construction Company, Chicago; first vice-president, J. R. Johnson, Viaduct Manufacturing Company, Baltimore, Md.; second vice-president, S. J. Tunbridge, Utica Fire Alarm Telephone Company, Utica, N. Y.; secretary, Paul W. Bossart, Minneapolis, Minn. The office of treasurer was left vacant pending another meeting, the secretary being instructed to act in that capacity temporarily.

The members of the executive committee comprise the officers ex-officio and the following: H. T. Johnson, Manhattan Electric Supply Company, New York; P. C Burns, American Electric Telephone Company, Kokomo, Ind.; H. C. Dodge, Standard Electric and Telephone Company, Madison, Wis.; M. O. Anthony, The Anthony Company, Cincinnati, O.; J. G. Ihmsen, Keystone Telephone Company, Pittsburg, Pa.

The next meeting of the Association will be held at Pittsburg, Pa., at an early date.

The Berliner Opinion.

It was expected that the United Circuit Court at Boston would hand down its opinion in the Berliner case on June 10, but up to noon of Tuesday of this week it had not been made public. It is thought, however, that the court will undoubtedly deliver the opinion during the present week.

Annual Meeting of the German Union of Electrical Engineers.

Electrical engineers who are going abroad this summer may be interested to know that the annual meeting of German electricians will be held at Munich, July 4 to 7.

The Triumphant Trolley.

A recent issue of a railway journal, after denouncing the proposed aerial wirerope railway over the Niagara Falls, gives vent to its feelings with the significant inquiry: "Are there to be no places on earth exempt from the invasion of the trolley?"

Niagara Falls Meeting of the American Institute of Electrical Engineers.

Following is the preliminary programme of the American Institute of Electrical Engineers for its Niagara Falls meeting, which will be held at the Cataract House, beginning on Tuesday, June 25, at 10 a. m., and continuing four days. The papers to be presented are as follows:

1. "The Substitution of Electricity for Steam in Railway Practice," inaugural address by the president, Dr. Louis Duncan, of Baltimore.
2. "Properties of Fuse Metals when Subjected to Short Circuits," by Walter E. Harrington, of Camden, N. J.
3. "Location of Grounds in Armatures, Fields, etc.," by Clarence E. Gifford, of Jamestown, N. Y.
4. "Some Features of Alternating-Current Systems," by Chas. P. Steinmetz, of Schenectady, N. Y.
5. "General Theory of Alternating-Current Transformer," by Chas. P. Steinmetz, of Schenectady, N. Y.
6. "Compounding Dynamos by Armature Reaction," by Elihu Thomson, of Lynn, Mass.
7. "Existing Commercial Applications of Electrical Power from Niagara Falls," by W. L. R. Emmet, of Schenectady, N. Y.
8. "Alternating-Current Curves," by Dr. C. E. Emery, of New York.
9. "Electric Power in Factories," by Prof. Francis B. Crocker, Messrs. Benedict and Ormsbee, of New York.
10. "Some Observations on a Direct-Connected 300-kw Monocyclic Alternator," by Prof. Dugald C. Jackson and S. B. Fortenbaugh, of Madison, Wis.
11. "On Mechanical Models of the Electric Current," by Prof. Brown Ayres, of New Orleans, La.
12. "On the Cause of Death in Electric Shock," by Albert M. Bleile, M. D., of Columbus, O.
13. "Long-Distance Power Transmission at 10,000 Volts," (The Pomona Plant), by George Herbert Winslow, of Pittsburg.
14. "Notes on the Reconstruction of a Small Central Station Plant," by Franklin Leonard Pope, of Great Barrington, Mass.
15. "On Rating the Performance of Electric Power Plants and Transmission of Varying Loads," by Prof. Wm. S. Aldrich, of Morgantown, W. Va.
16. "Work of the Westinghouse Electric & Manufacturing Company for the Cataract Construction Company of New York," by L. B. Stillwell, of Pittsburg.

Among the objects of engineering interest which it is proposed to visit are the new works of the Niagara Falls Power Company, the Niagara Falls Park & River Railway on the Canadian side, the aluminum plant of the Pittsburg Reduction Company, the plant of the Carborundum Company, the central station of the Niagara Falls and Buffalo Electric Light & Power Company.

The date of the meeting has been fixed with a view to accommodating all who may wish to visit the Falls during the most desirable season. Members are requested to invite their friends, either ladies or gentlemen. Should a sufficient number of favorable responses be received, reduced railway rates may be secured. The hotel rate will be $3 per day and upward, according to room, at the Cataract House. Those who prefer will find the International convenient.

The convention rate of one and one-third fare for the trip has been granted by the Trunk Line Association, conditional upon an attendance of 100 members and guests. This covers the Grand Trunk (in part), N. Y. C. & H. R. R. R., West Shore, N. Y. O. & W., Erie, D. L. & W., L. V. R. R., C. R. R. of N. J., P. & R., B. & O., C. & O., Pennsylvania, and other minor lines. Similar concessions are expected from other lines, east, south and west, the above covering only the territory east of Niagara and north of Pittsburgh, except New England. In order that transportation arrangements may be made in good time, members should inform the secretary promptly of their intention to attend the meeting.

The Northwestern Electrical Association.

The summer meeting of the Northwestern Electrical Association will be held at Chicago on July 17, 18 and 19. The meeting is expected to be one of much interest, both professionally and socially, and all members of Western and Northwestern central stations and supply houses are invited to attend. The business sessions will be held in the forenoons, the afternoons and evenings to be devoted to pleasure and recreation.

On the Theory of Units.

BY TOWNSEND WOLCOTT.

In connection with the articles of Prof. Fessenden in your issues of May 4 and 18 I wish to make some suggestions.

To begin at the beginning, the most obvious purpose of dimensional formulæ is to determine the change of the magnitude of a derived unit, which results from changing the magnitude of one or more of the fundamental units. For instance, the dimensions of unit length area and volume are, respectively, L, L^2 and L^3. If we change our unit of length from say the foot to the yard, we have the new unit of length equal to 3 times the old, the new unit of area equal to 3^2 or 9 times the old, and the new unit of volume equal to 3^3 or 27 times the old. To convert the numerical expressions for given lengths, areas and volumes from the old to the new system, he must divide them by 3, 9 and 27, respectively.

This is so elementary that some may ask why attention should be called to it here at all. The answer is that simple as is this use, it and allied uses are the only legitimate ones to which dimensional formulæ can be put. There is, however, a school of philosophers who think quite otherwise. This school appears to have been founded by Prof. Rücker; at all events Prof. Rücker is its principal exponent, and has several worthy followers. According to the views of this school the principal use of dimensional formulæ is to discover the ultimate constitution of matter and to solve other like questions regarding the fundamental physical properties of things.

According to the Rückerian philosophy, because some derived units, such as those of area volume and velocity, have always the same dimensions, all other derived units, such as those of electric and magnetic quantities, must really have the same dimensions always, and if they appear not to, it is because of our defective knowledge of the subject.

This conclusion, however, is a non-sequitur. The reason that certain derived units have always the same dimensions is because they are always defined by the same properties, or relations to other things. For instance, velocity is always defined as length divided by time, and we are not even able to think of any other way of defining it, because we do not know of any relation between the physical quantities—length, time and velocity—independent of this one. So the dimensions of unit velocity are always given as LT^{-1}. So likewise there being no known relation between the relative magnitudes of lines and surfaces independent of the elementary theorem that the areas of similar surfaces are as the second powers of their homologous linear measurements, the dimensions of unit area are always L^2.

This is not the case, however, with all units. As Prof. Fessenden truly remarks, there are two independent properties of matter—gravity and inertia—and these give us two ways of defining force and energy. As kinetic energy is one half the product of a mass by its velocity we have, as in the ordinary system, the dimensions of energy ML^2T^{-2}, and as potential energy is the line integral of force and by the conservation of energy the two kinds of energy are numerically equal, we have dimensions of unit force MLT^{-2}. Now we may make an independent start thus: let us define unit force as the force of gravity between two unit masses at unit distance. We thus obtain dimensions of unit force (from the known laws of gravitation) M^2L^{-2} which gives dimensions of unit energy M^2L^{-1}.

We here have two different expressions for the dimensions of unit energy, which, according to the Rückerian philosophy (as expounded by Mr. Kennelly in former utterances and by Prof. Fessenden in the two communications under discussion), proves that we have made a mistake somewhere. But to those who place full confidence in the laws of algebra, this proves that the two ways of defining energy are really independent.

The dimensional symbols are perhaps not, strictly speaking, symbols of quantity, but it seems to be taken for granted by all (with the possible exception of the Rückerians), that they may be operated on according to the laws of ordinary algebra. If we have $1n$ simultaneous and independent equations of condition between $n+$ unknown quantities, we all know and no one disputes that it requires one arbitrary assumption in addition to make the system determinate.

The arbitrary condition assumed may be anything we like (that is, strictly arbitrary), but it cannot be two different things at once, or, in other words, any one of any number of arbitrary conditions may be true, but no two independent assumptions can be true at once. If, therefore, we make two assumptions at once not knowing whether they are independent or not, and find by trial that each gives a different set of values to the unknown quantities, we at once conclude that the assumptions are independent.

This is what we have just done with the unit energy. If we are convinced that it is impossible for energy to have more than one dimensional expression, we will equate the two expressions thus: $M^1 L^{-1} = M L^2 T^{-2}$, and then say that there is a mistake somewhere, but the only *algebraical* conclusion we can draw from this equation is that the three quantities M, L and T are not independent, but one is a function of the other two. If we eliminate M we have the astronomical system explained in Maxwell's and Prof. Everett's books.

In other words, after having defined energy by the kinetic method, its dimensions in terms of length, time and mass are determinate, and we are not at liberty to make another arbitrary condition. However, by making one of the so-called fundamental units a function of the other two we reduce the number of independent conditions, which allows us to make another arbitrary condition in the shape of a gravity definition of force.

As Prof. Fessenden quotes Prof. Rücker's remarks as found in Prof. Everett's book I will refer to the same. The quotation as found on pages 209 and 210 of Prof. Everett's book is "If electrical and magnetic actions are to be regarded as manifestations of ordinary laws of dynamics applied to motions which our present knowledge does not allow us to specify, then every electrical or magnetic quantity has definite dimensions in terms of mass, length and time, hence the expression $K^{\frac{1}{2}} \mu^{\frac{1}{2}} L T^{-1}$ must be of dimensions $M^0 L^0 T^0$, in other words $K^{\frac{1}{2}} \mu^{\frac{1}{2}}$ must be the reciprocal of a velocity."

If I understand the reasoning of this passage, it means that if we could find out the ultimate nature of things, and if it proved true that all electrical phenomena are due to more or less complex mechanical motions, then and only then will $K^{\frac{1}{2}} \mu^{\frac{1}{2}} = L^{-1} T$. This equation, however, is true in both the electrostatic and electromagnetic systems separately, in their present state, and does not depend on the truth of any particular theory of the ultimate nature of things, but upon the method of defining the units.

Now for Prof. Fessenden's equation (1) this would read, with an obvious typographical error corrected, $M^{\frac{1}{2}} L^{\frac{1}{2}} T^{-2} \mu^{\frac{1}{2}} = M^{\frac{1}{2}} L^{-\frac{1}{2}} T^{-\frac{1}{2}} T^{-\frac{1}{2}} \mu^{-\frac{1}{2}}$. Solving this for μ by the methods of ordinary algebra; that is, by collecting all the μ terms in one member, and all the other terms in the other members, and observing the law of indices, it becomes $\mu = L^{-1} T$, and combining this with equation (2) $K\mu = T^2 L^{-2}$, we have $L^{-1} T = T^2 L^{-2} K^{-1}$ which reduces to $K = T L^{-1}$. How Prof. Fessenden obtains his values in equations (A) and (B), I do not understand.

However, assuming for the nonce that Prof. Fessenden's values are correct, I cannot understand the logic of his interjecting them into the electrostatic and electromagnetic systems, and then saying that the resulting values are *the correct values in these systems*, and that the present values are incorrect. In the present electromagnetic system the dimensions of resistance are $L T^{-1}$. In the practical system the unit length is 10^9 centimetres and the unit time 1 second, from which we conclude that the ohm is equal to 10^9 C. G. S. units of resistance. Prof. Fessenden gives as the corrected dimensions of resistance $L^2 M T^{-2}$. This would give (the unit mass in the practical system being 10^{-11} grammes), 10^7 C. G. S. units equal to the ohm. Does Prof. Fessenden seriously maintain that there are, or even that there ought to be only 10^7 C. G. S. units in the ohm?

The starting point of the Rückerian philosophy seems to be in the dimensions, or, more correctly, in the lack of dimensions of magnetic permeability. The fact that permeability, although a physical property of bodies, has no dimensions in length, time and mass, seems to some very mysterious. The reason that permeability has no dimensions in length, time and mass in the electromagnetic system, is because it is so by hypothesis. As before stated, in order to form a connected system of units at all it is necessary to make a certain number of arbitrary assumptions, and the dimensionless permeability is one of the assumptions in the electromagnetic system. Not, to be sure, an explicit assumption, but implicitly contained in the definitions of those units where permeability is concerned.

The permeability of the air is unity both in the C. G. S. and practical systems. The permeability of any other substance, such as a piece of iron, has the same numerical value under the same conditions whatever be the magnitude of the units of length, time and mass. Therefore, as the magnitude of the unit permeability is in nowise related to the magnitudes of the fundamental units it cannot have any dimensions in the same.

The same reasoning applies to the unit of specific inductive capacity in the electrostatic system. The specific inductive capacity of any given substance is expressed by the same numerical value, whether the units of length, time and mass are the centimetre, gramme and second, or anything else we please.

The dimensions of the unit of any quantity have nothing to do with its ultimate physical nature, or even with its physical properties, if such it has, which are independent of those by which the unit is defined in the particular system.

If we equate the dimensional expressions for the unit of the same quantity in two systems, it requires in general the suppression of one of the arbitrary conditions before assumed. This we have already seen in the case of energy defined by two independent methods.

In like manner if we equate, as Prof. Fessenden has done, the dimensional expressions for two different quantities, we must suppress one condition, which existed before in order to allow the new condition expressed by the equation to be true. This new condition, according to my results, is for Prof. Fessenden's equation (1) $L = T$.

This does not mean that length and time are the same thing, nor even that any physical property of the two is the same, but simply that in order that the equation should hold true, we cannot change the unit length without changing the unit time in the same ratio, and *vice versa*.

The exponents of L and T being different in the two members any alteration of the magnitude of unit length or time separately would cause a different alteration in the two units which are respectively represented by the two members of the equation, thus destroying the equality. But the sum of the exponents being the same in both members, if length and time are never altered separately, but both together and in the same ratio the equality is preserved. Thus, as previously shown $\mu = L^{-1} T = K$ in consequence of the equation (1), but also $K\mu = L^{-2} T^2$ in both electrostatic and electromagnetic systems before equation (1) is assumed. Therefore after assuming equation (1) $T = L$.

In other words, if we make a system in which the unit length is 10^9 centimetres, as in the practical system, but instead of retaining the second as in the latter, adopt 10^9 seconds as unit time, then will the units of electric and magnetic force at a point in this system contain each the same number of respective C. G. S. units. This is the only result I have been able to deduce from equations (1) and (2), unless the fact that it applies equally to the electrostatic system be considered a different result.

In order to form a system of units fulfilling the condition $L = T$, we observe that in this system the dimensions of velocity are $M^0 L^0 T^0$. Take any velocity which is fixed, either absolutely, or within the limits of error of measurement, such as the velocity of light in interstellar space, and call it unit velocity. Now if we assume any unit of length such as the centimetre, the unit of time is also determined, as the time which light takes to travel one centimetre. If we take the earth's quadrant as unit length, we have 10^9 centimetres, but we also multiply the unit time by 10^9, and the velocity of light remains unity.

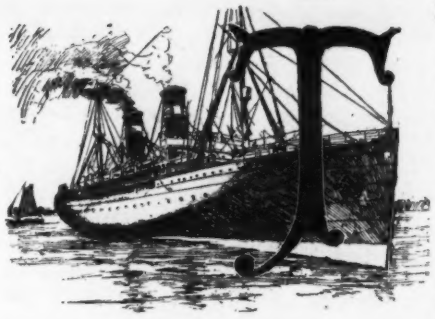
Profs. Rücker and Fessenden have written the foregoing equations in the interest of the search for the lost dimensions of one unit, and of course it is unkind to use them for the purpose of depriving still another unit of its dimensions, but if any one will show how (according to strict algebraic rules) the equation (1) can be satisfied without the condition $L = T$, I will gladly abandon my position on this point.

The dimensionless state of velocity in this case has no physical significance whatever. It does not prevent a velocity from being equal to a length divided by a time in the same sense as before. The *number of linear units* in a given distance divided by the *number of units of time* which a moving object requires to pass over the distance, gives the *number of units of velocity* in the motion of the body.

This case is entirely analogous to the case of permeability in the electromagnetic system. If $\mathfrak{C}$ and $\mathfrak{B}$ are so defined that their dimensions are the same, then of course the dimensions of $\frac{\mathfrak{B}}{\mathfrak{C}} = \mu$ disappear, but there is nothing mysterious in this, and it does not result from our ignorance, for the dimensions of a particular unit are to a great extent optional.

I do not understand, even according to the principles of Rückerian philosophy, how the equation $m/L^4 = m/L^3 \times 1/L$ shows that the ether has inertia depending first on its density, and second on curvature, but if it does prove this, there is practically no limit to the power of discovery, and as dimensional formulæ are largely optional we can to a great extent make the laws of Nature to suit ourselves.

Electricity on the St. Louis.



THE new American line ocean steamship, the *St. Louis*, which started on her maiden transatlantic voyage last Wednesday, is the largest vessel ever built in the United States, and one of the very few merchant vessels constructed in an American dock yard since the war, which can be considered truly creditable to a nation that for the quarter of a century previous to 1860 reigned supreme in the domain of naval architecture. Thanks to the experience gained by our ship-builders in the construction of the men-of-war of our new navy, we are now in a position to resume our former standing in this great art, and it is hoped that the *St. Louis* is but the forerunner of a merchant fleet that will carry the flag into every port of the world. As the object of this article is to deal only with the part that electricity plays on the new steamship, merely a brief resumé of its other details will be given.

The displacement of the *St. Louis* is 16,000 tons, and on her trial trip it is stated a speed of 22.75 knots was attained with 24,000 horse power. Her length is 555 feet, her beam 63 feet and the depth of hold 42 feet. The engines, of which there are two sets—one to each of the twin screws—are of the 6-cylinder quadruple expansion type. There are six double and four single boilers, 15 feet 7½ inches in diameter, the former each containing eight and the latter four furnaces; the double boilers are 20 feet long and the single boilers 11 feet, the steam pressure being 200 pounds. Forced draft on the Howden system is used, the air being heated before admittance to the furnaces. There are two elliptical smoke pipes, 11 feet 6 inches by 14 feet, and 100 feet high. The vessel has accommodations for 320 first-cabin, 200 second-cabin and 850 steerage passengers, and carries a crew of 400.

All of the electrical machinery required for the *St. Louis* except four ash-hoisting motors was manufactured by the Electro-Dynamic Company, of Philadelphia, who are also the electrical engineers for this vessel and for the sister ship, the *St. Paul*, now being built at Cramps' ship yard.

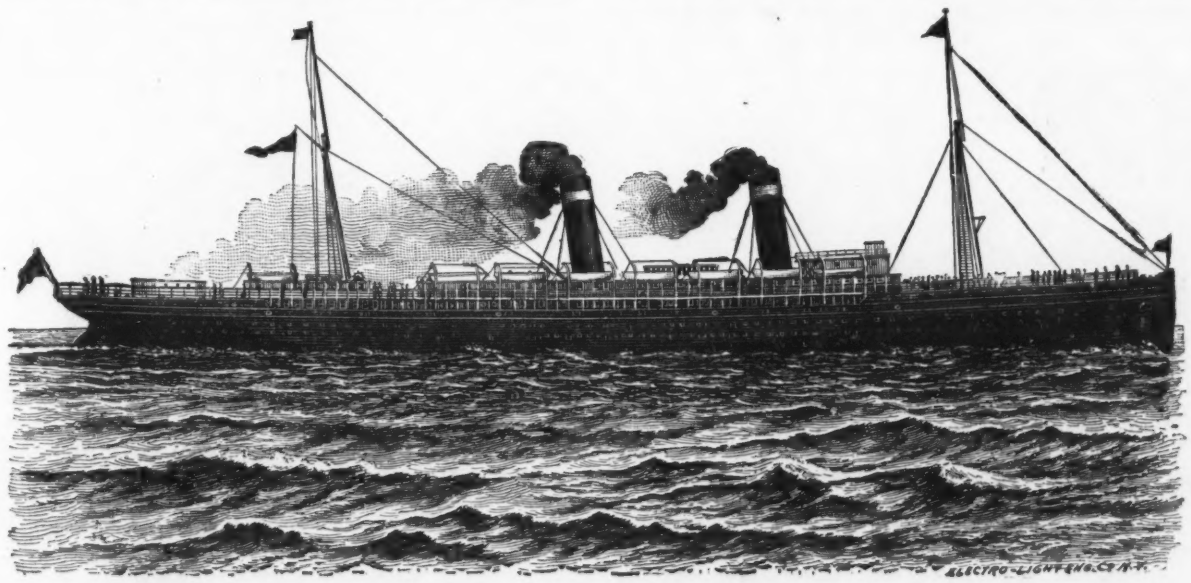
The dynamo room of the vessel is located on the main deck, amidships, just forward of the main engine room, and is above the water line, thus insuring the continuance of lighting until the last moment in case of accident. Four generating sets are installed, each set consisting of a dynamo of 360 amperes capacity at 115 volts, direct-connected to a 9-inch × 5½-inch double vertical, Sturtevant engine of the marine type, running at a speed of 475 revolutions per minute at 100 pounds boiler pressure and 20 pounds back pressure. Each set rests upon a common bedplate made of I-beams riveted together, the entire frame being designed so as to combine lightness with strength and rigidity. The engine is connected to the dynamo by an insulated coupling.

The dynamos are of the Gramme ring, smooth-core, four-pole type, having but one layer of wire on the surface of the armature. The field frames are of re-annealed cast steel having a very high permeability, thus making the dynamos very light in weight—an important point in marine work. The magnetic density is just below the bend of the saturation curve, and the compounding is such that the voltage is maintained between 110 volts, the no-load reading, and 112½ volts, the half-load reading; the full-load reading is 112 volts, there being a reduction of speed of about 2 per cent. from no load to full load.

The brushes, of which there are 12 to each machine, are of leaf copper, carbon tipped, and require no adjustment from no load to full load. The carbon tip is small, and is supported on a flexible spring which allows the brush to follow the commutator in every vibration of the armature. The connections from the armature to the commutator are made with flexible cable, which prevents the frequent breaks that occur with solid wire connections. The main connections to the commutator are by means of copper tips and screws, the tips being soldered to the flexible cable.

Each dynamo is provided with two self-aligning bearings, it being considered best to have the dynamo complete in itself. The bearings are self-oiling and have wick-feed oilers, by means of which the oil is filtered as used, thus allowing no grit to get into the bearings. Three wires connect each dynamo to the switchboard—two main conductors and an equalizing wire—so that two or more generators may be run in parallel, though the switching is such that any circuit may be placed on any dynamo. There is practically no stray field, all the external iron being in the form of a connecting yoke, the poles having very little area other than that facing the armature.

The engines of these generating sets were made by the B. F. Sturtevant Engine Company, of Boston, Mass., and are designed to develop 60 horse-power at a boiler pressure of 100 lbs. with a back pressure of 20 lbs.; the main boiler pressure of 200 lbs. is reduced by a valve inserted in the steam pipe leading to the dynamo room. The engines are of the pillow type, single valve, double acting, the cylinders being 9 inches × 5½ inches. The piping connections are such that the exhaust may be led direct to the condenser or to the low-pressure or intermediate cylinder receivers of the main engines.



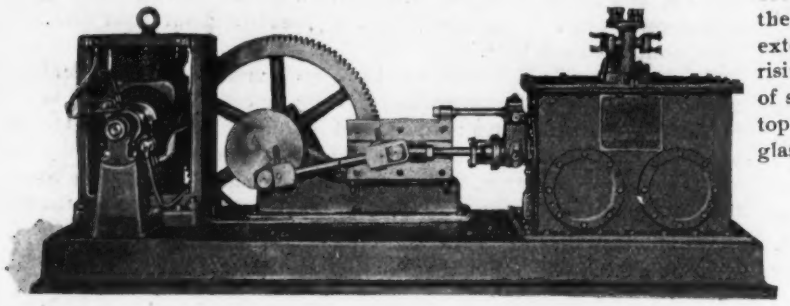
AMERICAN LINE STEAMSHIP, *St. Louis.*

The main switchboard, situated in the dynamo room, is 9 feet 3 inches long, and 5 feet 11 inches high, and made up of six slabs of marbleized slate secured to a frame built of angle iron. Upon the board are mounted four double-pole double-blade switches, used for running the dynamos in parallel. Also, 18 four way switches, one for each circuit of the ship, the circuits throughout the vessel being so arranged as to permit any circuit to be run from any one of the dynamos.

Upon the board are also placed four illuminated-dial Weston ammeters and one illuminated-dial Weston voltmeter and a ground detector, the latter being a duplicate of the voltmeter and

so arranged that it can be used as a check on it. The bus bars at the back of the board are of flat copper. Adjoining the switchboard are placed 18 small double-pole knife switches, which are used for controlling the night lights scattered throughout the vessel.

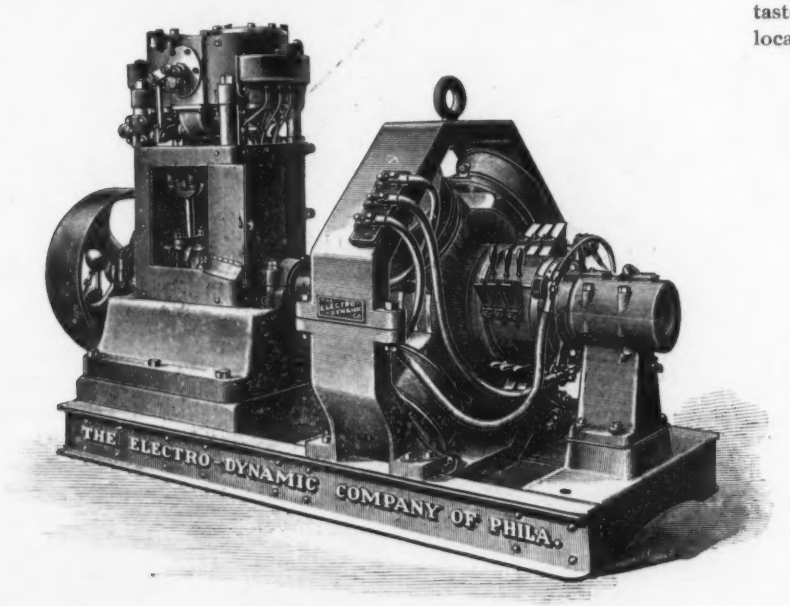
One of the electrical features of the *St. Louis* is the large use made of motors for auxiliary purposes. For ventilation and heating there are four motors of 5 horse-power, two of 7 horse-power and two of 9 horse-power, each running a Sturtevant blower. By means of



Motor Driving Refrigerator.

these blowers air for warming the staterooms and other parts of the ship is forced through nests of steam piping, and the vitiated air withdrawn through an exhaust system; the occupant of each stateroom can control the ventilation, being able to regulate the admittance or exhaustion of air. In warm weather cool air drawn from above deck is similarly distributed throughout the ship. For hoisting ashes from the fire-rooms there are four Storey motors; two motors of 10 horse-power furnish power for the refrigerating apparatus, and one of 7½ horse-power operates an elevator in the refrigerator room. There is also a small motor located in the casing of the main saloon dome to run the blower of the electric organ, being controlled from a small switch located on the keyboard of the organ.

The ship is wired throughout with two circuits, one a general lighting circuit and the other a police circuit for standing lights. Over 18 miles of wire were required for the various lighting and motor circuits, all of which was supplied by the Safety Insulated Wire & Cable Company, New York, and tested by the engineer of

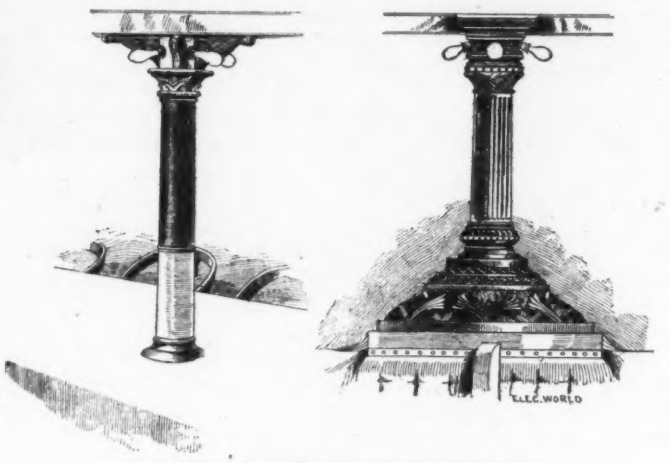


One of the Generating Sets.

the Electro-Dynamic Company before shipment. The wire is "navy standard," and has an insulation resistance of 1,000 megohms per nautical mile at 72 degrees F., and 25 megohms at 212 degrees F. Iron-armored conduit is exclusively employed, there being over one mile of it in the engine rooms alone.

There are altogether 1,757 lights in the ship, of which about 200 are in the engineer's department. Distributing closets are located at appropriate intervals throughout the ship through which both circuits pass and in which are the fuses and switches controlling all the various circuits of the vessel. These distributing closets—47 in number, and especially designed for this installation—are water tight, and the switches are so applied that they may be operated without disturbing this feature. The fuses are thus centralized, there being no individual fuses on fixtures or groups of lamps. There is no wiring in the cold storage rooms, the lamps for use there having a flexible cord attachment to plugs located outside the rooms.

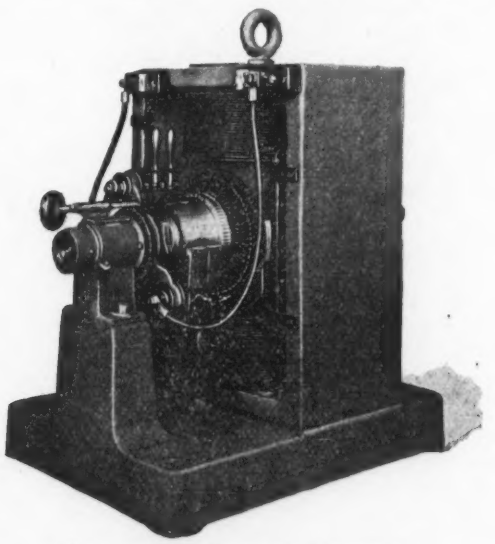
The electrical fixtures in the saloons and staterooms are neat, and in artistic harmony with their surroundings, no attempt having been made to produce purely electrical effects, if we may except the lighting of the main saloon. This magnificent apartment is 110 feet long by 50 feet wide and has sufficient sitting capacity for all the 320 cabin passengers. Above the central portion of the saloon extends a cylindrical glass dome, 32 feet long by 16 feet wide, and rising to a height of 25 feet amidships, the surface being composed of squares of handsome cathedral glass of light neutral tints. The top of the hatch into which the dome extends is covered with plain glass, and beneath this upper plane surface are distributed 84 lamps



Columns with Incandescent Lamps.

of 16 candle-power each, the light of which is transmitted through the cathedral glass of the dome into the saloon.

In the other portions of the main saloon, in the main passages, the library, ladies' saloon and elsewhere, lamps are placed at the heads of columns, the accompanying sketches showing the neat and tasteful arrangement for this purpose; intermediate lamps are located overhead, as also shown. All of the fixtures were especially

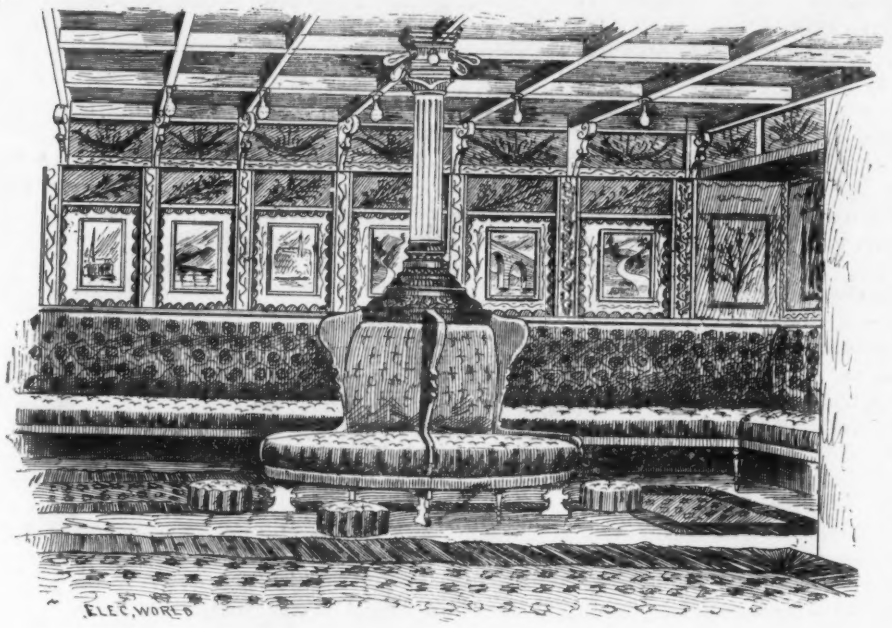


One of the Blower Motors.

designed for the ship by the Kosenko & Hetherington Manufacturing Company, of Philadelphia.

At the forward end of the saloon is a fine pipe organ, provided with an electro-pneumatic action which renders it practicable to elevate the organ about eight feet above the floor so as to allow free passage under it, as shown in the illustration of the main saloon. The keyboard is located below on the saloon deck, 30 feet forward of the organ. Each key has a circuit-closer attached which controls a very small magnet located within the organ case; this magnet actuates a valve to admit or exhaust compressed air to or from a little pneumatic bellows, which, in turn, controls the pallet or valve of the speaking pipe. The draw-stops, combination pedals and

swell pedal are all equipped with electro-pneumatic action constructed on the same general principle, but carried through several "relays" of pneumatic devices in order to obtain the greater power necessary to operate these several mechanisms. A small electric motor, as described above, operates the bellows. The organ is a single-manual instrument, with nine stops, three combination pedals and balanced swell, and was furnished by Messrs. Geo. Jardine & Son, of New York, the widely known organ builders.



A CORNER OF THE LIBRARY.

In the engine room the fixtures are steam-tight pendants, especially designed and manufactured by Page Bros. & Co., of Boston, who also furnished the cargo reflectors. The engine room is painted white, and the illumination is most effective, the light being diffused by reflection, while the lamps have been carefully distributed to give the strongest light where most necessary. Much credit is due to Mr. C. J. Dougherty, electrical engineer of the Cramps, for the very efficient manner in which a proper distribution of light here and elsewhere throughout the ship has been secured.

Large reflectors, 2½ feet in diameter, and each containing six lamps of 32 candle-power each, are used in the hold. These reflectors are portable, numerous plug connections being installed, to which electrical attachment can be made.

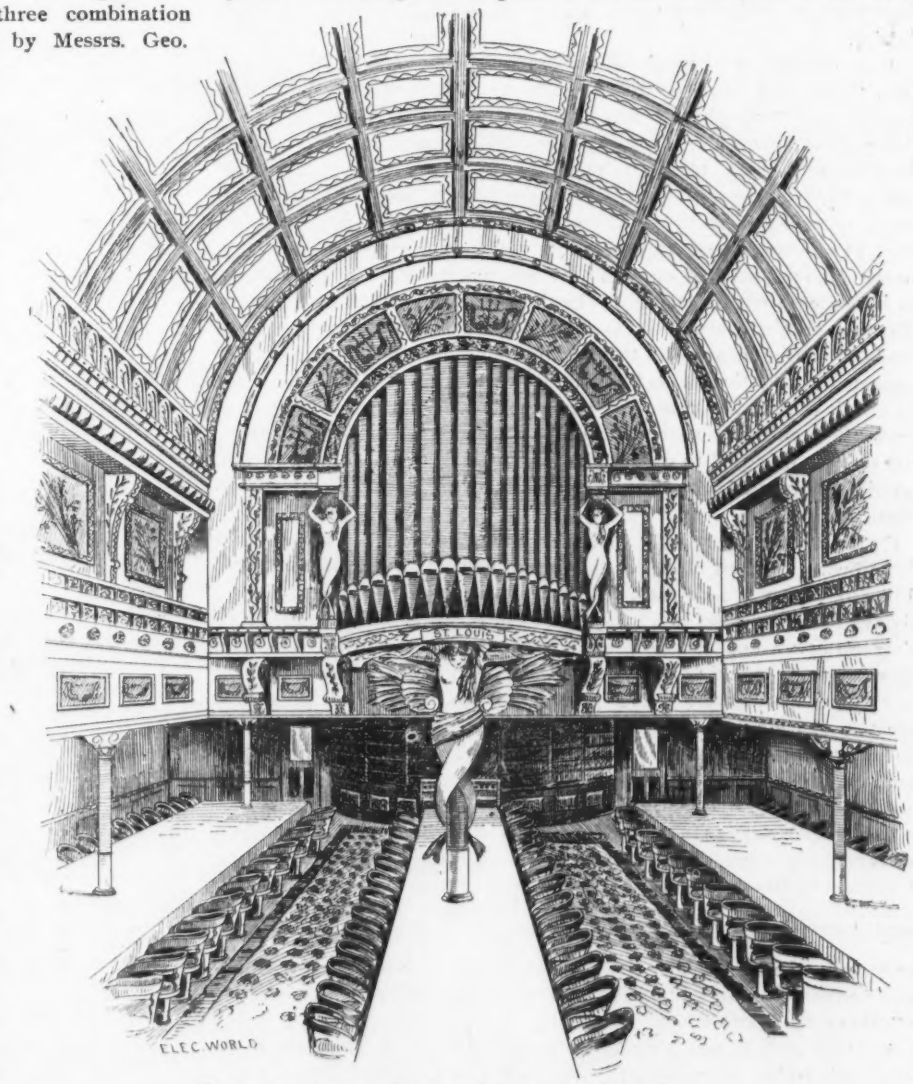
The ship is wired throughout for a complete system of electric call bells, the push buttons in all cases being fitted with a white thermostat button instead of the ordinary rubber button used in a push. Fusible alloy in these buttons is made to melt at a temperature of 168 degrees F., at which the spring in the bottom will be released and close the bell circuit, thus calling the attention of the steward or other attendant to the compartment, thus affording an efficient safeguard against fire. The bell circuits are operated by a small motor-generator driven from the main lighting circuits and with the additional safety device of a switch to throw the bell circuits into the main system through a resistance box in case of accident or damage to the motor-generator; provision is also made to connect in a few cells of storage batteries. The bell system was put in by Chas. H. Cory & Sons, New York.

There are two incandescent lamps in the lanterns of the four running lights—port and starboard, forward mast-head and stern—and are so connected to a tell-tale that should one of the lights in any lantern go out, or either be injured in any way, the tell-tale will give the alarm as well as show a signal to the man in the pilot house. This tell-tale device was especially designed for the purpose, none having been found on the market that was considered sufficiently reliable.

The ship is fitted with electric rudder and revolution indicators. The former consists of a rheostat of 220 ohms placed in the lighting circuit, and an arm on the tiller which travels along contact points connected with the resistance. A voltmeter is connected between the arm and central point of rheostat, and as the arm cuts in or out resistance the voltmeter indicates accordingly. The latter has an illuminated dial and is graduated in degrees corresponding to the angle of the rudder, the rheostat being so proportioned that the voltmeter divisions are proportional to this angle. Any number of voltmeters correspondingly graduated and located in any part of the ship can, of course, be connected.

The revolution indicator consists of two magneto generators belted, one to each shaft, and of illuminated voltmeters connected in each magneto circuit, the dials being graduated in revolutions. These indicators, which read both ahead and astern, are located, one in the wheel house and another in the chief engineer's room.

The entire electrical installation was done under the supervision of Mr. Mathias Pfatischer of the engineering department of the Electro-Dynamic Company, who also designed many of the novel features of the plant. The design of the plant as a whole is the work of Mr. L. T. Paul, engineer of the same company, who also had general supervision of its execution. The Electro-Dynamic Company is now placing a similar equipment on the *St. Paul*, a sister ship.



ELECTRIC ORGAN UNDER DOME OF MAIN SALOON.

The Output of Polyphase Generators and Rotary Transformers.

BY RALPH D. MERSHON.

In consequence of the rapid development of polyphase power transmission the amount of available literature on the subject is comparatively small. For this reason there are many points of both theoretical and practical interest which, while they may be well understood by those actively engaged in the design and testing of polyphase machinery, are not known to engineers in general. The following paper, dealing with the output of polyphase apparatus of the closed-circuit type of winding, takes up a question of this kind, and is thought to be worthy of consideration, not only because the subject is an interesting one, but because in many cases the results arrived at have a direct commercial value.

If a direct-current dynamo, whose armature has the ordinary closed-circuit winding, have added to it two or more collector rings connected to the armature winding at suitable points, such a machine may be used as a direct-current generator, as an alternating-current generator, or as a rotary transformer for transforming from alternating to direct current or from direct to alternating current. In what follows a two-pole machine of the above description will be dealt with, though the statements made will all, with obvious changes in their wording, apply equally well to machines having a greater number of poles. The points of attachment of the collector rings to the armature winding are supposed to be so chosen that the length of the shorter path between any two adjacent points of connection is the same as that between any other two adjacent points. In this case, when all the collector rings bear the same effective ($\sqrt{\text{mean square}}$) current, the effective current in all parts of the armature is the same. Such a machine may be called a *symmetrical polyphase machine* and when the collector rings all bear the same effective current it may be said to be *symmetrically loaded*.

It is customary to speak of apparatus of the above type having two, three and four collector rings as "single-phase," "three-phase" and "two-phase" machines respectively. This method of designation recognizes only phase differences other than 180 degrees, and such machine might very properly be called *two-phase*, three-phase and *four-phase*. For there may be formed as many external circuits as there are leads from the armature (see Fig. 1) and no two of these circuits will bear currents of the same phase although pairs of circuits may bear currents 180 degrees apart, as is the case with a machine having an even number of leads. For the present purpose it is more convenient to adopt the latter mode of designation, and the number of phases will, therefore, be regarded as identical with the number of leads. It should be borne in mind that in the case of a machine having an even number of leads the result is precisely the same whether the number of external circuits be equal to or only half as great as the number of leads, providing that in both cases the leads bear the same effective currents.

Consider a symmetrical polyphase machine such as has been described. If when used in its several capacities of direct-current dynamo, rotary transformer, or alternating-current dynamo, it be run always with the same loss in the armature copper, its output as an alternating-current machine will, in general, differ from that as a direct-current machine and will depend upon the number of phases it receives or delivers being greater as the number of phases is greater. In what follows the endeavor is made to show how the output varies as the number of phases is varied. The output will in each case be expressed in terms of the output of the machine when used as a direct-current dynamo.

Let Fig. 1 represent the closed-coil armature of a two-pole generator giving a sine wave. A and B are two circuits each attached to the armature at points separated by the length of armature winding l, where l equals $\frac{1}{n}$ th of the total length of armature winding. The resistances of the circuits A and B are non-inductive, and are so adjusted that they have in them equal effective currents whose values at any instant are $c \sin\theta$ and $c \sin(\theta+a)$. θ is the angle between the line ab, corresponding to the diameter of commutation, and the middle point of the section of armature winding included in circuit A, the direction of rotation being counter clock-wise; $a = \frac{2\pi}{n}$ is the angular length of a section of armature winding l. The portions of armature winding included in circuits A and B, are supposed to have no electromagnetic interaction. This is permissible since the line of reasoning developed here will presently be applied to the case of an armature having its n circuits equally loaded, in which case, since the actions and reactions of a given portion of the winding are equal and opposite, each circuit may be regarded as though electromagnetically independent of the remaining circuits.

The inside arrows show the directions through the armature of the current of A, and the outside arrows, those of the current of B, when the circuits A and B are separately active. If the resistance obtained by cutting the armature winding and measuring the resistance between the terminals thus obtained be R, the resistance of the shortest armature path between any two adjacent leads is $\frac{R}{n}$ and that of the longest is $\frac{n-1}{n} R$. Therefore if the circuit B is opened and the current $c \sin\theta$ allowed to flow in A, the current in the short path of the armature will be $+\frac{n-1}{n} c \sin\theta$ and that in the long path $-\frac{1}{n} c \sin\theta$.

The latter has the negative sign because, as can be seen from Fig. 1, it has a direction around the armature winding opposite to that of $\frac{n-1}{n} c \sin\theta$. Similarly, if the circuit A is opened and a current $c \sin(\theta+a)$ allowed to flow in B, the currents in the short and long armature paths will be $+\frac{n-1}{n} \times c \sin(\theta+a)$ and $-\frac{1}{n} c \sin(\theta+a)$ respectively. If now the currents $c \sin\theta$, and $c \sin(\theta+a)$ be allowed to flow at the same

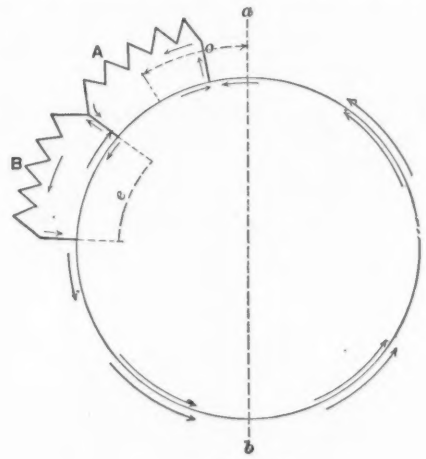


Fig. 1

time in their respective circuits A and B, the resultant current at any instant in any part of the armature winding may be determined by adding together with their proper signs the currents which at that instant would flow in that part of the armature winding if A and B were separately active. Therefore, the current in the short armature path corresponding to the circuit A is

$$\frac{n-1}{n} c \sin\theta - \frac{1}{n} c \sin\theta(\theta+a).$$

If, instead of two circuits as in Fig. 1, we have n circuits from which equal effective currents are drawn, the current in any part of the armature at any instant will be equal to the algebraic sum of all the currents which would exist there if each of the n external circuits were in turn to separately bear the current which flows in it at that instant. Let there be n leads brought off symmetrically from the armature and the n separate circuits equally loaded. Let the current in these circuits be

$$c \sin\theta, c \sin(\theta+a), c \sin(\theta+2a), c \sin(\theta+3a)$$
$$\ldots\ldots\ldots\ldots + c \sin(\theta+(n-1)a), \text{ where } a = \frac{2\pi}{n}.$$

Then it follows from what has been said above that the current in any short armature path, as that corresponding to the circuit whose current is $c \sin\theta$, will be

$$\frac{n-1}{n} c \sin\theta - \frac{1}{n} c \sin(\theta+a) - \frac{1}{n} c \sin(\theta+2a), \text{ etc.}$$

$$\text{or } \frac{n-1}{n}\, c \sin\theta - \frac{1}{n}\, c \left[\sin(\theta+a) + \sin(\theta+2a) \ldots\ldots \right.$$
$$\left. + \sin(\theta+(n-1)a)\right]$$

The term in the bracket equals

$$(\sin\theta\cos a + \cos\theta\sin a) + (\sin\theta\cos 2a + \cos\theta\sin 2a)$$
$$\ldots\ldots\ldots\ldots + (\sin\theta\cos(n-1)a + \cos\theta\sin(n-1)a)$$
$$= \sin\theta(\cos a + \cos 2a + \cos 3a \ldots + \cos(n-1)a)$$
$$+ \cos\theta(\sin a + \sin 2a + \sin 3a \ldots + \sin(n-1)a).$$

Since $a = \frac{2\pi}{n}$ where n is an integer, the sum of the sines is zero and that of the cosines is -1. Therefore we have for the current in the short path corresponding to the external circuit bearing the current $c \sin\theta$.

$$\frac{n-1}{n}\, c\sin\theta - \frac{1}{n}\, c\sin\theta\,(-1) = c\sin\theta.$$

Therefore, in any symmetrically loaded closed-coil alternator the current in that section of the armature winding which is included between the points of attachment of any two adjacent leads, is at every instant equal to the current in the shortest external circuit connecting these leads. (By a symmetrically loaded machine is meant, of course, one from which leads are brought off symmetrically and whose external circuits bear equal effective currents.) It follows, then, that the effective currents in the two cases are equal.

If E be the E. M. F. and C_{dc} the current when the machine is carrying full load as a direct-current dynamo, the output is $EC = W_{dc}$. The effective E. M. F. of a circuit whose leads are attached to the ends of a diameter is $\frac{E}{\sqrt{2}}$ since E will be the maximum E. M. F. of the circuit. Then, as has been shown in a preceding paper*, the effective E. M. F. of each of the n alternating-current circuits led off from this armature will be $\frac{E}{\sqrt{2}} \sin\frac{\pi}{n}$. If the effective current in each of the n external circuits be C_{ac} the output of the machine as an alternating-current generator is $n\frac{C_{ac}E}{\sqrt{2}} \sin\frac{\pi}{n} = W_{ac}$. C_{ac} and C_{dc} bear a definite relation given by the equation

$$\frac{C^2_{dc}R}{4} = n\ C^2_{ac}\frac{R}{n}$$

since the copper losses in the two cases are to be equal.

$$\therefore C^2_{ac} = \frac{C^2_{dc}}{4} \text{ or } C_{ac} = \frac{C_{dc}}{2}$$

$$\therefore W_{ac} = \frac{n\,C_{dc}}{2\sqrt{2}}\ E\sin\frac{\pi}{n}$$

$$\therefore \frac{W_{ac}}{W_{dc}} = W_r = \frac{n\frac{C_{dc}}{2\sqrt{2}}\cdot E\sin\frac{\pi}{n}}{E\,C_{dc}} = \frac{n\sin\frac{\pi}{n}}{2\sqrt{2}} \qquad (1)$$

which is the expression for the output of a generator of n phases in terms of its output when used for direct current. If the total loss with direct current is p per cent., the loss with alternating current is $\frac{2\sqrt{2}\times p}{n\sin\frac{\pi}{n}}$ per cent., and the efficiency is $100 - \frac{2\sqrt{2}\times p}{n\sin\frac{\pi}{n}}$

The value of equation (1) has been calculated for several values of n, and the results plotted in Fig. 3. The curve A has been run through these points, though strictly no such curve exists, since the output is physically a discontinuous function of the number of armature leads.

The case of the rotary transformer is somewhat more complicated. Let Fig. 2 represent the armature of the machine into which direct current is put and from which alternating current is taken, or the reverse. Though it is immaterial as far as the result is concerned which way the transformation takes place, it is assumed that the transformation is from direct to alternating current. D. C.,— D. C. are the direct current brushes and the inside arrows indicate the course which the direct current would take if it alone flowed through the armature. The outside arrows where drawn indicate the direction of alternating current under similar conditions. All the n alternating circuits are supposed to have in them the same effective currents and the instantaneous values of them are as before $c\sin\theta$, $c\sin(\theta+a)$, etc. Then, as before, the instantaneous values of the alternating currents which would be in each short section of the armature winding if alternating currents only were flowing are the same as those of the currents which flow in the circuits corresponding to these sections; they are, $c\sin\theta$, $c\sin(\theta+a)$, $c\sin(\theta+2a)$, etc.

It is desired to find the mean loss in each section when both direct and alternating currents are flowing. This can be accomplished by summing up the losses which take place in a given section while rotating through an angle π and dividing the result by π. Consider any particular one of the n sections as that corresponding to the current $c\sin\theta$. As long as it is wholly on one side or the other of the diameter of commutation, the numerical value of the current in it is, as is evident from Fig. 2, $\frac{C_{dc}}{2} - c\sin\theta$ where C_{dc} is the total direct current flowing through the direct current brushes. When, however, this section is passing from one side to the other of the diameter of commutation as shown at b, Fig. 2, the above expression does not give the value of the current. It will be convenient, therefore, to sum up separately the losses in the section under consideration when it is wholly on one side of the diameter of commutation and when it is passing from one side to the other. Suppose the rotation of the armature in Fig. 2 to be counter clock-wise. Then remembering that θ, $\theta+a$, $\theta+2a$, are the angular distances between the middle points of their respective sections of the armature winding and the upper D. C. brush, and that $a = \frac{2\pi}{n}$

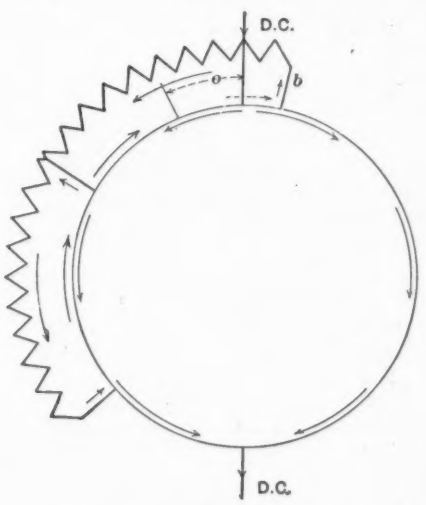


FIG. 2.

is the angular length of one section, the loss in the section corresponding to $c\sin\theta$, may be most conveniently found for the half revolution extending from the angle $\theta = -\frac{a}{2}$ to the angle $\theta = (\pi - \frac{a}{2})$. The two parts of this which must be determined separately extend from $\theta = -\frac{a}{2}$ to $\theta = +\frac{a}{2}$ and from $\theta = +\frac{a}{2}$ to $\theta = \pi - \frac{a}{2}$. The loss over the part of the half revolution extending from $+\frac{a}{2}$ to $\pi - \frac{a}{2}$ is

$$\int_{\frac{a}{2}}^{\pi-\frac{a}{2}} \frac{R}{n}\left(\frac{C_{dc}}{2} - c\sin\theta\right)^2 d\theta \qquad (2)$$

the loss as the section passes over the angle from $-\frac{a}{2}$ to $+\frac{a}{2}$ can be divided into two exactly similar and equal parts, namely, the loss taking place during the movement from $-\frac{a}{2}$ to 0 and that during the movement from 0 to $+\frac{a}{2}$. It is

* ELECTRICAL WORLD, Dec. 15, 1894, "Some Notes on Multiphase Power Transmission."

most convenient to determine the loss during the movement over the latter angle and the section at one instant of this movement is shown at *b*, Fig. 2. From this diagram it is evident that the current in that part of the section which has passed the D. C. brush is $\frac{C_{dc}}{2} - c \sin\theta$, while that in the other part of the section is $\frac{C_{dc}}{2} + c \sin\theta$ and the resistances through which these currents flow are $\frac{R}{2\pi}\left(\frac{a}{2} + \theta\right)$ and $\frac{R}{2\pi}\left(\frac{a}{2} - \theta\right)$ respectively. Therefore, the rate of loss at any instant in the two parts of the section are

$$\left(\frac{C_{dc}}{2} - c \sin\theta\right)^2 \frac{R}{2\pi}\left(\frac{a}{2} + \theta\right) \text{ and } \left(\frac{C_{dc}}{2} + c \sin\theta\right)^2 \frac{R}{2\pi}\left(\frac{a}{2} - \theta\right)$$

Therefore the loss during the movement of the section from $\theta = -\frac{a}{2}$ to $\theta = +\frac{a}{2}$ is,

$$2\int_0^{\frac{a}{2}} \left(\frac{C_{dc}}{2} - c \sin\theta\right)^2 \frac{R}{2\pi}\left(\frac{a}{2} + \theta\right) d\theta + 2\int_0^{\frac{a}{2}} \left(\frac{C_{dc}}{2} + c \sin\theta\right)^2 \frac{R}{2\pi}\left(\frac{a}{2} - \theta\right) d\theta \qquad (3)$$

adding (2) and (3) and dividing the sum by π gives the mean loss in the section.

$$\therefore L = \frac{R}{\pi}\int_0^{\frac{a}{2}} \left[\left(\frac{C_{dc}}{2} - c \sin\theta\right)^2 \left(\frac{a}{2} + \theta\right) + \left(\frac{C_{dc}}{2} + c \sin\theta\right)^2 \left(\frac{a}{2} - \theta\right)\right] d\theta + \frac{R}{n}\int_{\frac{a}{2}}^{\pi - \frac{a}{2}} \left(\frac{C_{dc}}{2} - c \sin\theta\right)^2 d\theta$$

$$\pi$$

Since there are n sections the mean loss in the armature will be n times this; hence multiplying by n and reducing

$$n\,L = \frac{n\,R}{\pi^2}\int_0^{\frac{a}{2}} \left(\frac{a\,C_{dc}^2}{4} + a\,c^2 \sin^2\theta - 2\,C_{dc}\,c \sin\theta\right) d\theta + \frac{R}{\pi}\int_{\frac{a}{2}}^{\pi - \frac{a}{2}} \left(\frac{C^2_{dc}}{4} - C_{dc}\,c \sin\theta + C^2 \sin^2\theta\right) d\theta.$$

The integral of this expression is, since $\int \sin^2 x\,dx = \frac{x}{2} - \frac{\sin x \cos x}{2}$ and $\int x \sin x\,dx = \sin x - x\cos x$,

$$\frac{n\,R}{\pi^2}\left[\frac{a\,C^2_{dc}\,\theta}{4} + a\,c^2\left(\frac{\theta}{2} - \frac{\sin\theta\cos\theta}{2}\right) - 2\,C_{dc}\,c\left(\sin\theta - \theta\cos\theta\right)\right]_0^{\frac{a}{2}} + \frac{R}{\pi}\left[\frac{C^2_{dc}\,\theta}{4} + C_{dc}\,c\cos\theta + c^2\left(\frac{\theta}{2} - \frac{\sin\theta\cos\theta}{2}\right)\right]_{\frac{a}{2}}^{\pi - \frac{a}{2}}$$

Evaluating and substituting the values

$$a = \frac{2\pi}{n} \text{ and } \pi - a = \pi - \frac{2\pi}{n} = \left(\frac{\eta - 2}{n}\right)\pi$$

$$n\,L = \frac{C^2_{dc}\,R}{4} - \frac{2\,C_{dc}\,c\,n\,R \sin\frac{\pi}{n}}{\pi^2} + \frac{C^2\,R}{2} = K_1 \qquad (4)$$

where K_1 is the full load loss in the armature copper when the machine is run as a direct current generator. Let E be the D. C. E. M. F. generated in the machine. E is the E. M. F. on the D. C. brushes, if alternate current is put into the machine or the E. M. F. on the D. C. brushes less the copper drop in the armature if D. C. is put into the machine. As the latter case is that under consideration, E is the E. M. F. at the D. C. brushes less the copper in the drop armature. The result is the same, of course, in either case. The effective E. M. F. on each of the n A. C. circuits is $\frac{E \sin\frac{\pi}{n}}{\sqrt{2}}$. E is also the E. M. F. at which the machine would be run when used as a direct current dynamo, and since the copper loss of the armature is K_1 and the resistance of the armature $\frac{R}{4}$, the current when run as a direct current dynamo is $\sqrt{\frac{4K_1}{R}}$. The output as a direct current dynamo is therefore $E\sqrt{\frac{4K_1}{R}}$. If K_2 be the per cent. which the friction loss and the iron loss of the armature is of this output, the friction and armature iron losses are $K_2\,E\sqrt{\frac{4K_1}{R}}$. Therefore if C be the effective current in each A. C. circuit, the output when used as a transformer is

$$W_{ac} = E\,C_{dc} - K_2\,E\sqrt{\frac{4K_1}{R}} = \frac{n\,E \sin\frac{\pi}{n}\,c}{2} \qquad (5)$$

For, since E is the counter E. M. F., $E\,C_{dc}$ represents the total power delivered to the armature less the copper loss, and this diminished by the iron and friction losses must equal the power delivered to the external *A. C.* circuits.

If W_r be the output as a rotary transformer in terms of the output as a direct current dynamo,

$$W_r = \frac{W_{ac}}{W_{dc}} = \frac{n\,E \sin\frac{\pi}{n}\,c}{2} \cdot \frac{1}{E\sqrt{\frac{4K_1}{R}}} = \frac{n \sin\frac{\pi}{n}\,c}{2\sqrt{\frac{4K_1}{R}}} \qquad (6)$$

From (5),

$$C_{dc} = \frac{n \sin\frac{\pi}{n}\,c}{2} + K_2\sqrt{\frac{4K_1}{R}}$$

Substituting this value of C_{dc} in (4) and solving, the value of c is obtained. Substituting this value in (6), there results,

$$W_r = -(\pi^2 - 8)\,K_2\,n^2 \sin^2\frac{\pi}{n} + n \sin\frac{\pi}{n}\left[(\pi^2 - 8)^2\,K_2^2\,n^2 \sin^2\frac{\pi}{n} + 4\pi^2(1 - K_2^2)\left(\left(\frac{\pi^2}{4} - 4\right)n^2 \sin^2\frac{\pi}{n} + 2\pi^2\right)\right]^{\frac{1}{2}}$$

$$4\left[\left(\frac{\pi^2}{4} - 4\right)n^2 \sin^2\frac{\pi}{n} + 2\pi^2\right] \qquad (7)$$

When the iron and friction losses are so small that they may be neglected (7) becomes,

$$W_r = \frac{n \sin\frac{\pi}{n}}{2\left[\left(\frac{\pi^2}{4} - 4\right)n^2 \sin^2\frac{\pi}{n} + 2\pi^2\right]^{\frac{1}{2}}} \qquad (8)$$

If the total loss as a direct current dynamo is p per cent, the efficiency as a rotary transformer is,

$$\text{Efficiency} = 100 - \frac{p}{W_r} \qquad (9)$$

Values of (7) have been calculated for different values of n when $K_2 = .02$; that is, when the iron and friction losses are 2 per cent. of the output as a direct current dynamo. These values have been plotted in Fig. 3 and the curve B run through them.

Fig. 3 shows that in a three phase system, if each of the converters receiving energy from the generator have its terminals connected to the generator armature at points 180 degrees apart instead of 120 degrees, so that there are six leads from the armature instead of three, the output of the generator will be increased about 16 per cent.; while for the same change in a three-phase rotary transformer the output is increased about 45 per cent. This gain is made at the expense only of three additional collector rings for the machine.

Fig. 3 also shows that the output as "quarter-phase" generator is about 10 per cent. greater than that as a three-phase generator, and that the output as a "quarter-phase" rotary transformer is about 22 per cent. greater than that as a three-phase rotary transformer.

Finally, Fig. 3 shows that in any polyphase system the output of all the apparatus of the closed-coil type, whether generators,

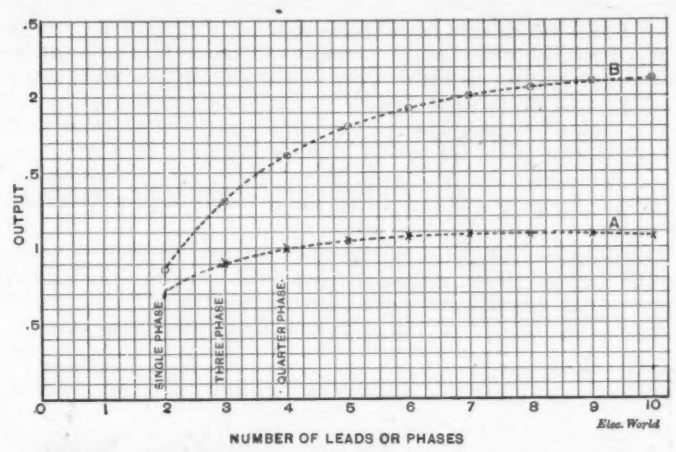


FIG. 3.

rotary transformers or motors, may be increased by increasing the number of phases supplied to or taken off from it. This applies also to the short-circuited secondary of an induction motor of the rotary field type, the output of the motor being increased by an increase in the number of points at which the secondary winding is short-circuited. It is obvious that along with such increase in the output of the apparatus there is an increase in efficiency.

There are two small errors in the above analysis of the rotary transformer. One of them is in the assumption that the iron losses and field copper losses are the same in the machine whether it be used as a rotary transformer or as a direct-current dynamo. They are not the same, both being somewhat greater in the case of the dynamo because of its greater armature reaction. The other error is in the assumption that when direct current is fed into a machine which inherently generates a sine wave, the alternating E. M. Fs. and currents taken from that machine will be sine waves. This is not true because of the redistribution of current in any given section as it passes under the direct-current brush, and the consequent departure, during this time, of the wave representing the energy lost in that section from the form which it has when the section is not under the brush. Both these errors are small, however, and the results obtained above are, as experience has shown, well within the accuracy of commercial measurements.

Progress in Gas Journalism.

A contemporary whose pages are devoted almost exclusively to the interest of gas, gives a brief analysis of the recent report for Massachusetts, saying that that State "lives up to her reputation as a leader in modern progress," which remark is followed by a statement showing that there are more companies supplying electric current than there are supplying gas, and that during the year 1894 the total gross receipts of all the gas companies fell 17.75 per cent., the total net profits 24.75 per cent., the entire operations showing a deficit of over $108,000, while with the electric light companies there was an increase in receipts, expenditures and profits, the deficit for 1893 having been replaced by a surplus. Such a frank admission by a gas journal is in itself an indication of progress.

Platinum Mines in Human Skulls.

Some time ago it was stated in these columns that in America about three tons of platinum was used annually for incandescent lamps, and one ton for artificial teeth. *L'Eclairage Electrique* in this connection suggests that for future generations the American cemeteries will become platinum mines. The editor of that journal is apparently not aware of the tricks of American undertakers.

Analogies.

Prof. Forbes in a recent lecture likens the reverse curbing current in submarine cables to the pullback when a whip is cracked, the sharp jerk causing a better defined and more vigorous effect than if the whip were merely thrown forward.

Some Work on Magnetic Hysteresis.

BY FRANK HOLDEN.

Having read the description of Prof. Ewing's latest apparatus for determining the hysteresis loss in sheet iron, it seemed that an account of work done some time ago in very much the same direction would be of interest.

During the last few weeks of the year 1892 there was built at the works of the General Electric Company, in Lynn, Mass., under the writer's direction, an instrument, shown in Fig. 1, by which the losses in sheet iron were determined by measuring the torque produced on the iron, which was punched in rings, when placed between the poles of a rotating electromagnet. The rings were held by a fibre frame so as to be concentric with a vertical shaft which worked freely on a pivot bearing at its lower end. They had a width of 1 cm, an outside diameter of 8.9 cm, and enough were used to make a cylinder about 1.8 cm high. The top part of this instrument, which rested on a thin brass cylinder surrounding the rings, was movable. On the upper surface was marked a degree scale, over which passed a pointer, with which the upper end of a helical spring rotated. It was so constructed that when the vertical shaft with the rings and the upper part of the instrument with the spring was put in place, the lower end of the spring engaged with the shaft, and, consequently, rotated with the rings. A pointer moving with the lower end of the spring reached to the zero of the degree scale when the apparatus was ready for use. By this arrangement it was found what distortion it was necessary to give the spring in order to balance the effect of the rotating magnet, and the spring having been calibrated the ergs spent on the rings per cycle were determined by multiplying the degrees distortion by a constant.

A coil, so arranged that it surrounded but did not touch the rings, made contact at its ends with two fixed brushes that rested in diametrically opposite positions on a two-part commutator, which revolved with the magnet. The segments were connected each to a collector ring against which rubbed a brush, the latter two brushes being joined through a sensitive Weston voltmeter. If this were so

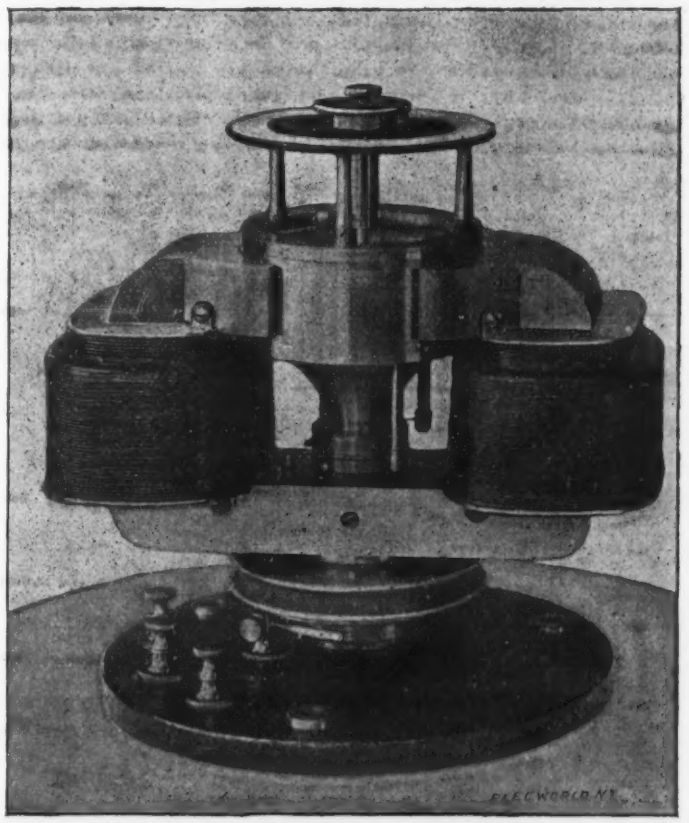


FIG. 1.—HYSTERESIS METER.

arranged that the coil was at right angles to the induction, when the brushes changed contact from one segment to the other, it is evident, the self-induction of the circuit being negligible, that the mean value of the current in the circuit was proportional to the total flux through the coil. Knowing the constant of the voltmeter the deflection was easily calculated from the speed of the magnet, the number of turns in the coil, cross-section of the rings and the

resistance of the circuit. From an induction of 2,000 gausses to at least 10,000 gausses, the leakage across the interior space of the rings was negligible.

Carried on the shaft below the magnet was a pulley around which passed a flat belt driven with a pulley of the same size on an electric motor, so that the speed of the magnet could be found by observing that of the motor. In operating, the deflections to be produced on the voltmeter at a certain speed, with the desired

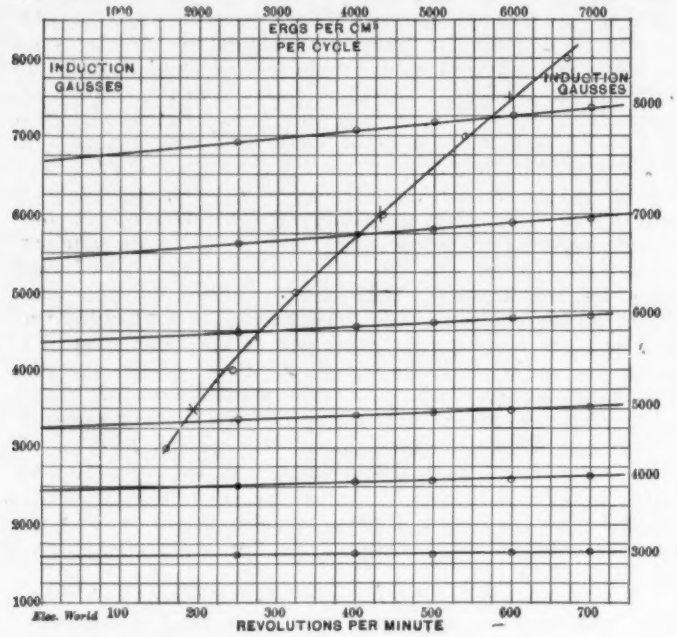


Fig. 2.

induction in the rings, were first calculated. Five hundred revolutions per minute was generally adopted as the speed in this case. The motor being run at the desired speed, the magnetizing current was adjusted until the calculated deflection was produced on the voltmeter. Keeping the magnetizing current constant the speed was changed successively in value to certain values, and the corresponding distortions of the spring necessary to balance the effect of the magnet noted. When this process was carried out at different induction values and the ergs expended per cycle on the rings

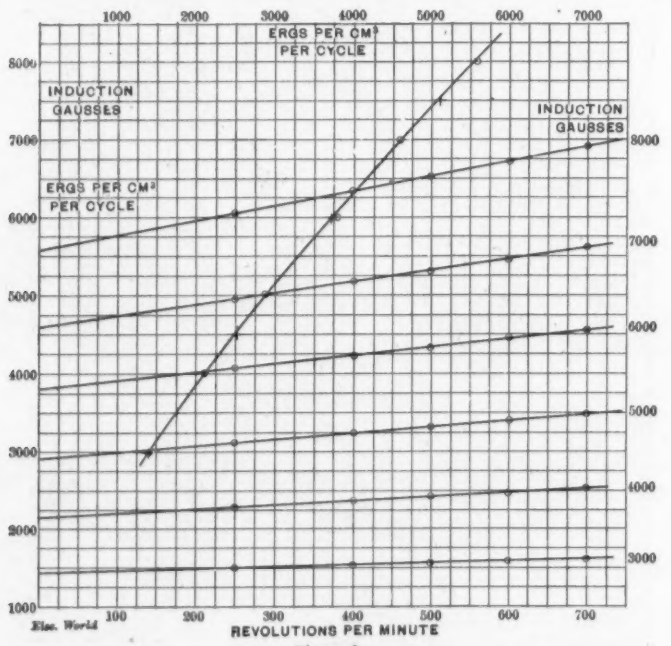


Fig. 3.

plotted as a function of the speed, a series of lines were produced, as shown in Figs. 2 and 3. It was found that the slope of the lines decreased very rapidly with the decrease in thickness of the iron sheet used so as to indicate that had it been thin enough the slope would have been zero between 100 and 800 revolutions per minute, which was about the highest speed permissible. From this it would seem that, in these tests, the total loss per cycle had two components; one remaining constant, due to hysteresis, and the other varying as the speed of the magnets, due to currents induced in the iron.

Fig. 6 gives observations of eddy current loss and thickness of iron sheet on this assumption. The line drawn is a parabola, so that it would appear that with the range of observations made the loss varied about as the square of the thickness of the sheets.

Fig. 2 gives lines from iron .04 cm thick. Speed readings were not taken lower than 250 revolutions per minute, as it had been found that the lines were always straight, and speeds below this value could not be read with the tachometer available for this particular test. Plotting the hysteresis as a function of the induction, in this case the points are all quite close to a curve whose equation is, Ergs $= K \mathfrak{B}^{1.47}$, three points in the latter calculated curve being shown by the crosses. The iron, a test on which is shown in Fig. 3, was .1 cm thick, and shows a greater eddy current loss. The equation for the hysteresis curve for this sample is, Ergs $= K \mathfrak{B}^{1.4}$, some points in the latter curve being shown by crosses, as before.

The eddy current losses for these two samples are plotted as functions of the induction in Fig. 5. The curves drawn are parabolas, showing that in these cases the eddy current loss varied approximately as the square of the induction, although there were often

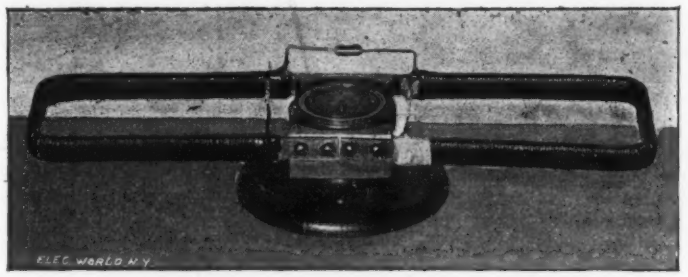


Fig. 4.—Modified Hysteresis Meter.

greater variations from that law than these two samples show. The average exponent for the hysteresis curves was a little over 1.5, although it varied from 1.4 to 1.7. Rings tested in this manner were wound and tested with a ballistic galvanometer, using the step-by-step method. There were discrepancies of as much as 4 per cent. between the two results, but an average of ten tests showed the ballistic galvanometer method gave results 2.5 per cent. lower than the other. This difference is easily attributable to experimental errors.

It being noticed that, for a given induction in the rings, the magnetizing currents for different samples did not vary much, it was planned shortly after completing the above apparatus to construct a modified instrument which would use electromagnets of such high reluctance that the variations of the rings would be negligible, and induction be dependent only on the current. By making the electromagnets of suitable iron and of about one third the cross-section of the rings used, the iron may be so highly saturated that the

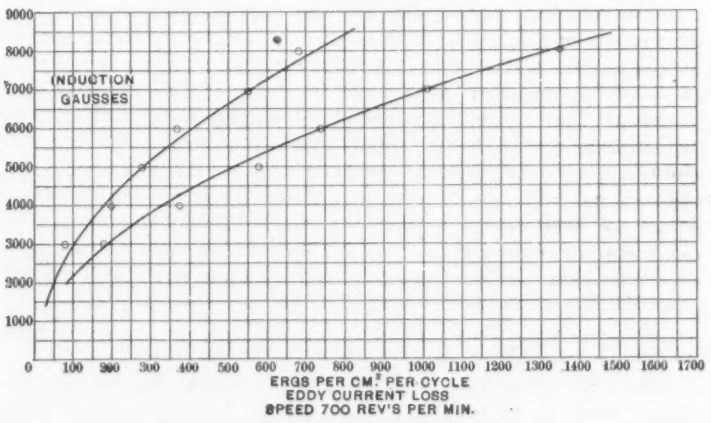


Fig. 5.

induction will remain quite constant under considerable variation in the magnetizing current, thus rendering unnecessary any accurate comparisons of magnetizing currents, and the rings can be at about their maximum permeability when thus magnetized. Such an instrument is shown in Fig. 4 in its original experimental form, with the rings in position ready for test. The rings are here allowed to rotate in opposition to the action of a spring and carry a pointer over a scale, so that it is quite direct reading. Twenty-five com-

parisons of this instrument with the original one gave results that agreed within 6 per cent. in all cases, and more than half were within 2 per cent. of agreement. Permanent magnets had been previously tried, but the attempt seemed to show that the instrument would not, in that case, compare samples of iron widely

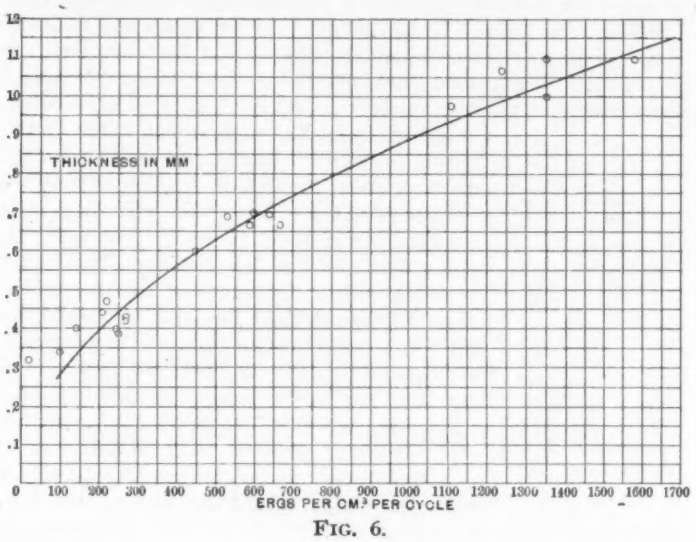


FIG. 6.

different in character, and the writer not being able to give any attention to the matter no further investigations in that direction were conducted.

The instrument first described has been in use continuously since its completion at the works of the General Electric Company, in Schenectady.

The Direct Production of Electricity from Hydrogen.

BY C. J. REED.

Under the above title Mr. H. H. Dow describes in THE ELECTRICAL WORLD of June 8, 1895, another new battery for the "direct production of electricity from fuel." The importance of this battery will be appreciated when it is understood that the "fuel" employed in it is metallic zinc. This is a very convenient and a very efficient fuel for the purpose, as has been shown by many others who have worked in the same line.

Mr. Dow calculates that he has obtained an efficiency of 57 per cent. of the original energy of this fuel. The fact that others have by a similar calculating process obtained as high as 97 or 99 per cent. efficiency is not of very great importance.

If Mr. Dow will study the reactions of the Grove, bi-chromate or any other zinc battery, in which an oxidizing agent is kept in contact with the electronegative plate to prevent the reduction and escape of hydrogen gas, he will learn that the energy all comes from the oxidation of the zinc. If hydrogen is evolved in any zinc battery, it means that the energy of the zinc is not all being used to produce electrical energy, but that a portion of it is being used to reduce hydrogen gas from combination. This energy is, of course, wasted when the hydrogen escapes. Whenever this is allowed to occur, the reaction, instead of producing electricity directly from hydrogen, is producing hydrogen, *i. e.*, reducing it, directly from the energy of the zinc. In the Grove, Bunsen and bi-chromate batteries and in all batteries using a powerful oxidizing agent which effectually prevents the reduction of hydrogen, we have the most highly efficient transformation of the energy of the zinc into electrical energy. Such batteries have an electromotive force approaching closely to the theoretical electromotive force of the chemical reaction in the battery.

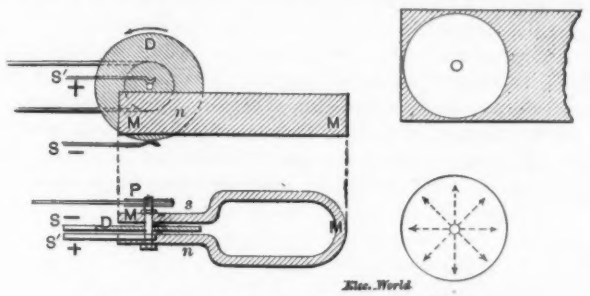
According to Mr. Dow's statement, his battery gives only 1.32 volts, which shows that the efficiency is very low, like that of the Smee battery, and the reasons are very apparent. To be a little more specific, we may say one gramme of zinc in Mr. Dow's battery will furnish 0.83 ampere-hour of electric current at 1.32 volts (assuming his figures to be correct); while one gramme of zinc in a bi-chromate cell will furnish 0.83 ampere-hour at about 2.1 volts. The difference between 1.32 and 2.1 or 0.78 volt represents the loss of electromotive force in the Dow battery due to the escape of energy in hydrogen gas and other unavailable by-products, which is saved in the bi-chromate battery. While the Dow battery would have a low efficiency and use more zinc, it would, like the Smee battery, require no oxidizing agent which is a source of expense. But to speak of this or any other zinc battery as one in which electrical energy is produced directly or indirectly from hydrogen gas, is nonsense pure and simple.

Electrodynamic Machinery.—XXXVIII.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

253. Commutatorless, continuous-current dynamos are sometimes called unipolar dynamos, although very erroneously. It is impossible to produce a single magnetic pole in a magnet, since all magnetic flux is necessarily circuital, and must produce poles, both where it enters and where it leaves a magnet. The fact that these machines are capable of furnishing a continuous current without the aid of a commutator, at one time caused considerable study to be given to them in the hope of rendering them commercially practicable. The maximum E. M. F. which they have been constructed to produce, appears, however, to have been about six volts, and, consequently, they have practically fallen out of use, although they have been commercially employed for electroplating.

254. Fig. 178 represents what is known as a Faraday disc. This



FIGS. 178 AND 179.—FARADAY DISCS.

was, in fact, the earliest dynamo ever produced and was of the so-called unipolar type; for here, a copper disc *D*, rotated by mechanical force, about an axis parallel to the direction of the magnetic flux, supplied by a permanent horseshoe magnet *MM*, continuously cuts magnetic flux in the same direction, and, consequently, furnishes a continuous E. M. F. between the terminals *S*, *S'* without the use of a commutator.

255. The portion of the disc lying between the poles is caused to rotate in a nearly uniform magnetic flux and with a velocity which depends upon the radius of the disc at the point considered, as well as on the speed of rotation. The direction of the E. M. F. induced will be radially downward from the axis to the periphery, and if connection be secured between the axis as one terminal, and the rotating contact or brush as the other terminal, an E. M. F. will be continuously produced in that portion of the disc which lies beneath the poles; or, more strictly, in that portion of the disc which passes through the flux between them and around their edges. If, however, as in Fig. 179, the disc be completely covered by the pole faces, a radial system of E. M. Fs. will be induced outward in the direction indicated by the arrows, or, upwards, if the direction of rotation be reversed. If no contacts are applied to the disc, these E. M. Fs. will supply no current and will do no work. If brushes are applied at the axis, and at any or all parts of the periphery, the E. M. F. can be led off to the external circuit.

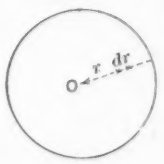


FIG. 180.

256. The value of the E. M. F. will depend upon the speed of rotation, the intensity of the magnetic flux, and the radius of the disc. The intensity of the magnetic flux can usually be made much greater by the use of a soft-iron disc instead of a copper disc, thereby practically reducing the reluctance of the magnetic circuit between the poles to that of two clearance films of air, since the reluctance of the iron disc will be negligibly small.

257. If we consider any small length of radius dr, Fig. 180, situated at a distance r, from the axis of the disc, the E. M. F. generated in this element of the disc will be the product of the intensity, the length of the element, and its velocity across the flux. The element will be moving across the magnetic flux of uniform intensity at O, a velocity $r\omega$ centimetres-per-second, where ω, is the angular velocity of the disc in radians per second. Consequently, the E. M. F. in this element will be:

$$de = r\omega \cdot dr \text{ C. G. S. units of E. M. F.}$$

The total $B_1 M_1 F_1$ will be the sum of the elementary E. M. Fs.

included in the radius taken from $r = o$ to $r = R$, the radius of the disc, or the integral of de, in the above equation between the limits $r = o$, and $r = R$. This integral is $\frac{R^2}{2} \omega \mathfrak{B} = e$. The E. M. F. from such a disc, therefore, increases as the square of the radius of the disc, directly as the speed, and directly as the uniform intensity of the magnetic flux. The same result can be obtained in a slightly different expression, since $\omega = 2 \pi n$, where n, is the number of revolutions of the disc in a second, $e = \frac{R^2}{2} . 2 \pi n \mathfrak{B} = \pi R^2 n \mathfrak{B} = S n \mathfrak{B}$ where S, is the active surface of the disc. This will also be true if the surface S, instead of extending over the entire face of the disc, extended only from the periphery to some intermediate radius. From this point of view the E. M. F. of the disc is equal to the product of the intensity in which it runs, the number of revolutions it makes per second, and its active surface in square centimetres. To reduce this E. M. F. to volts we have to divide by one hundred million.

258. There are two recognized types of commutatorless continuous-current dynamos; namely, the *disc type* and the *cylinder type*. The outlines of a particular form of the disc type are represented in Fig. 181. Here the shaft *SS*, usually horizontal, carries a concentric, perpendicular disc of copper or iron, rotating in a vertical plane, in the ring-shaped magnetic frame, and through the flux produced by two coils of wire in a circular groove. The general direction of the magnetic flux, through the field frame and disc, is represented by the curved arrows. It will be observed that the magnetic flux will be uniformly distributed so as to pass through

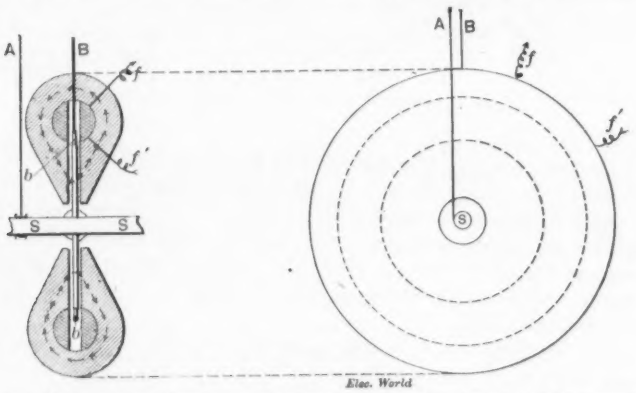


Fig. 181.—Disc Type of Commutatorless Direct-Current Generator.

the rotating disc at right angles. Brushes rest on the periphery, and on the shaft, of the disc. Inasmuch as the E. M. F. in the disc is radially directed at all points, the brushes for carrying off the current may be as numerous as is desired. These brushes are marked b, b, in the figure. A, and B, are the main terminals of the machine, and f, f', the field terminals.

259. If we suppose that the intensity $\mathfrak{B}$ is 12,000 gausses, that the radius of the disc is 1 foot or 30.48 centimetres, that the active surface on each side of the disc is 2,500 square centimetres, and that the speed of rotation is 2,400 revolutions per minute, or 40 revolutions per second, then the E. M. F. obtainable from the machine will be:

$$\frac{2{,}500 \times 40 \times 12{,}000}{100{,}000{,}000} = 12.0 \text{ volts.}$$

In order to produce an E. M. F. of say 140 volts, such as would be required for continuous-current central-station generators, it would be necessary to connect a number of such machines in series, to increase the diameter of the disc, or to increase its speed of rotation. It would, probably, be unsafe to run the disc at a peripheral speed exceeding 200 miles per hour, owing to the dangerously powerful mechanical stresses that would be developed in it by centrifugal force. This important mechanical consideration imposes a limit of speed of rotation and diameter of the disc, taken conjointly. By increasing, however, the active surface of the disc, and, at the same time, working at a safe peripheral velocity, it would be possible to construct large disc generators of this type for an E. M. F. of 100 or 150 volts.

260. It should be borne in mind that although such machines would be capable of producing continuous currents without the use of a commutator, yet the necessity of maintaining efficient rubbing contacts on the periphery of the rapidly-revolving disc, introduces a difficulty and waste of power which has, hitherto, prevented the development of this system, and probably accounts for the fact that large machines of this type do not exist.

261. Irregularities in the distribution of magnetic flux over the surface of the disc may give rise to strong eddy currents and waste of power in the same. If the flux be variable along any radius of the disc $O B$, as represented in Fig. 182, so that the intensity $\mathfrak{B}$, is not uniform along these lines, this irregularity will not produce eddy currents in the disc unless the distribution is different along different radii. In other words, if the distribution of magnetic flux and intensity are symmetrical about the axis of rotation of the disc, the irregularities which exist will only alter the intensity of E. M. F. in different elements of a radius. In Fig. 182 the intensity, instead of being uniform from centre to edge, as indicated by the straight line d, a, c, toward the edge, following the line o, a, b. The formula for determining the E. M. F. of the disc is in such case rendered somewhat more complex.

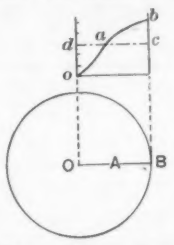


Fig. 182. — Diagram Showing Flux Density Through Disc Along a Radius.

262. If, however, the curve C, D, of flux intensity along different radii is different, so that the distribution of magnetic intensity is not symmetrical about the axis of rotation, then eddy currents will tend to form, the amount of power so wasted depending upon the amount of irregularities, the resistivity of the material in the disc, and the load on the machine.

263. Fig. 183 represents the outlines of a particular form of the second, or cylindrical type of commutatorless continuous-current generator. Here a metallic conducting cylinder *cccc*, revolves concentrically upon the shaft *SS*, through the uniform magnetic flux, produced by the field frame surrounding it. Here, however, two sets of brushes bb, $b'b'$, have to be applied to the edges of the cylin-

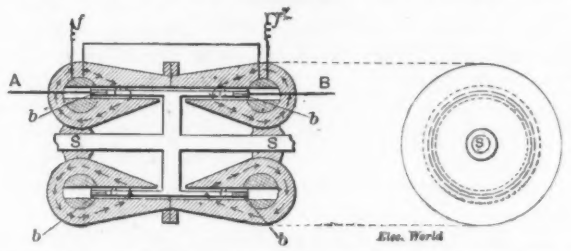


Fig. 183.—Cylinder Type of Commutatorless Direct-Current Generator.

der in order to supply the main terminals A and B. The terminals of the four circular coils constituting the field winding are shown at f, f'.

264. If the magnetic intensity produced by the field is uniform the E. M. F. will be generated in lines along the surface of the cylinder parallel to its axis, as represented in Fig. 184. If v, be the peripheral velocity of the cylinder in centimetres per second, l, the length of the cylinder in centimetres, and the uniform intensity, the E. M. F. generated by the machine will be:

$$e = \frac{v \, l \, B}{100{,}000{,}000} \text{ volts.}$$

Machines of the cylindrical type have been constructed and used for electrolytic apparatus, and give very powerful currents, as compared with ordinary generators of the same dimensions employing commutators. Unsatisfactory as these unipolar machines have so far proved, except in special cases, they are, nevertheless, the only dynamos which have yet been successfully constructed for furnishing continuous currents without the use of a commutator.

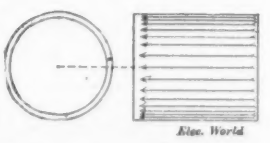


Fig. 184. — Indicating Direction of E. M. F. Induced in Revolving Cylinder.

(To be continued.)

Laboratory of Houston and Kennelly, Philadelphia.

New Use of Old Insulators.

The Belgian telephone and telegraph department announces that it desires to sell a lot of old insulators, and by way of a suggestion to purchasers it states that they may be used to advantage for making borders in parks and gardens!

Rope Driving—XX.

BY J. J. FLATHER.

Guide pulleys or idlers should be made with a semi-circular groove so that the rope runs upon the bottom instead of being wedged between the sides as in grip pulleys. Some engineers maintain that the wedge groove should be used in all cases, and

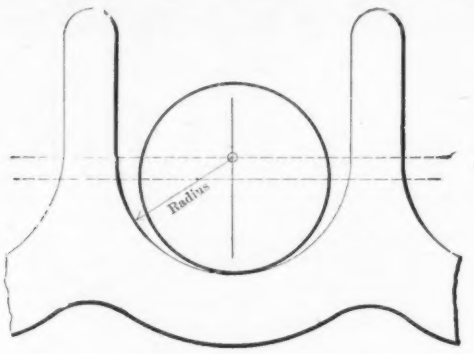


FIG. 57.—FORM OF GROOVE FOR GUIDE PULLEYS.

many plants are in operation having V-shaped grooves in the idlers, but we believe the most satisfactory results will be obtained by using a groove in which the rope runs on the bottom. Of these there are two general forms—the one in which the rope has considerable play in the groove, and the other of such form that the rope is embraced by a portion of the surface of the groove. The

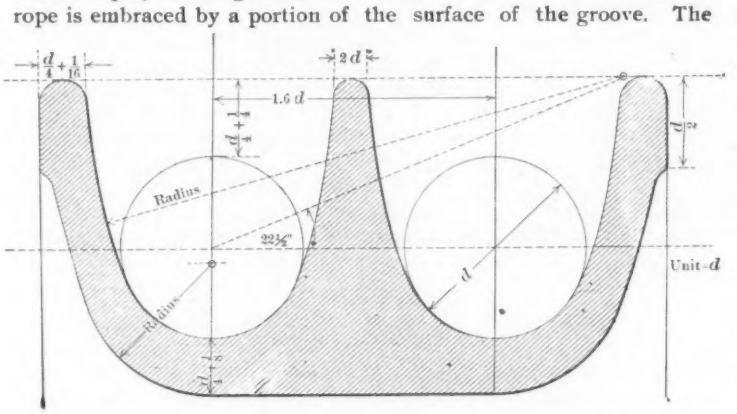


FIG. 58.—FORM OF GROOVE FOR GUIDE PULLEYS.

first is used more particularly for single ropes, while the latter is adapted to any number of wraps.

A modification of the first form is frequently used for a number of ropes, as shown in Fig. 57.

The proportions shown in Fig. 58 will be found very satisfactory for single or multiple groove guide pulleys, in which the pitch is equal to that used with the grip pulleys represented in Fig. 56. The general design conforms closely to the latter, but the pulley is somewhat lighter.

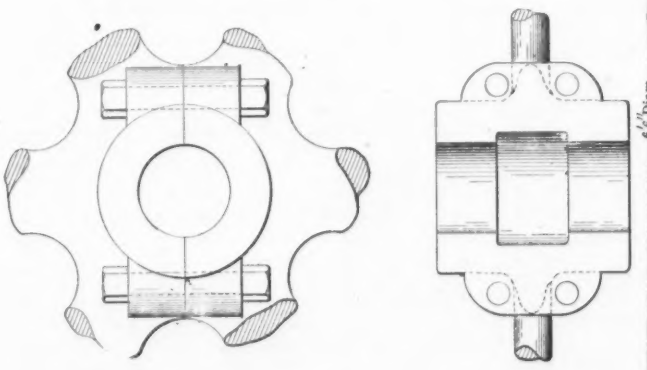


FIG. 59.

For shaft pulleys and the smaller sizes of fly-wheels not exceeding about 9 feet in diameter, the casting is usually made in one piece unless a "split" pulley is required. In order to relieve the wheel in cooling, the arms were formerly given a curved, or S shape, as this form yields more readily and is supposed to conform to the unequal contraction of the rim and hub of the pulley in cooling.

With properly proportioned wheels, however, and with due care in the foundry, straight-armed pulleys may be cast as readily as those of curved outline, and as the former are lighter, neater, and cheaper than the latter, they are now almost universally employed.

In the larger single casting pulleys the hubs are frequently split in order to favor the arms in cooling; when split by a diametral

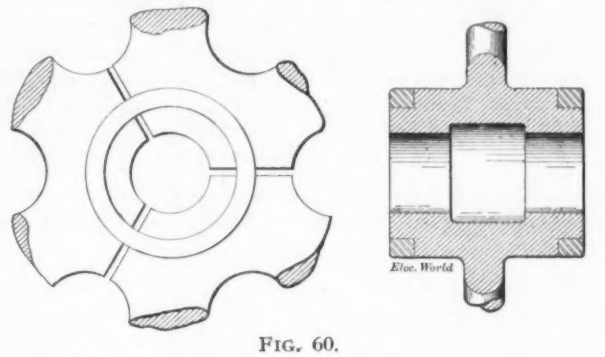


FIG. 60.

plane, the two portions at the hub are generally secured by bolts and nuts, as in Fig. 59, or less frequently by pins and cotters; when split in three, wrought iron or steel rings are shrunk into the ends of the hub which is turned to receive them, as represented in Fig. 60.

Occasionally rings are shrunk on and bolts used as well, but this precaution is not common practice.

There is no general rule by which the number of arms may be determined. For small rope pulleys the number is usually six, while for the larger sizes, six or eight arms are used for pulleys cast in one or two parts, but these in some cases have two sets of arms, as shown in Fig. 61, which represents a 78-inch pulley made by The Robert Poole & Son Company, for the Providence Cable Tramway Company.

The usual run of wheels from 9 feet to 15 feet in diameter are cast in halves, six or eight arms being employed.

Occasionally, however, narrow rope fly-wheels, of diameter up to 18 feet, are made in two pieces only, with eight arms. Moderate-sized wheels are frequently cast in one, but arranged so as to be readily split in two afterward.

Pulleys cast in halves having light rims should have double arms along the line of separation, as shown in Fig. 62, which represents

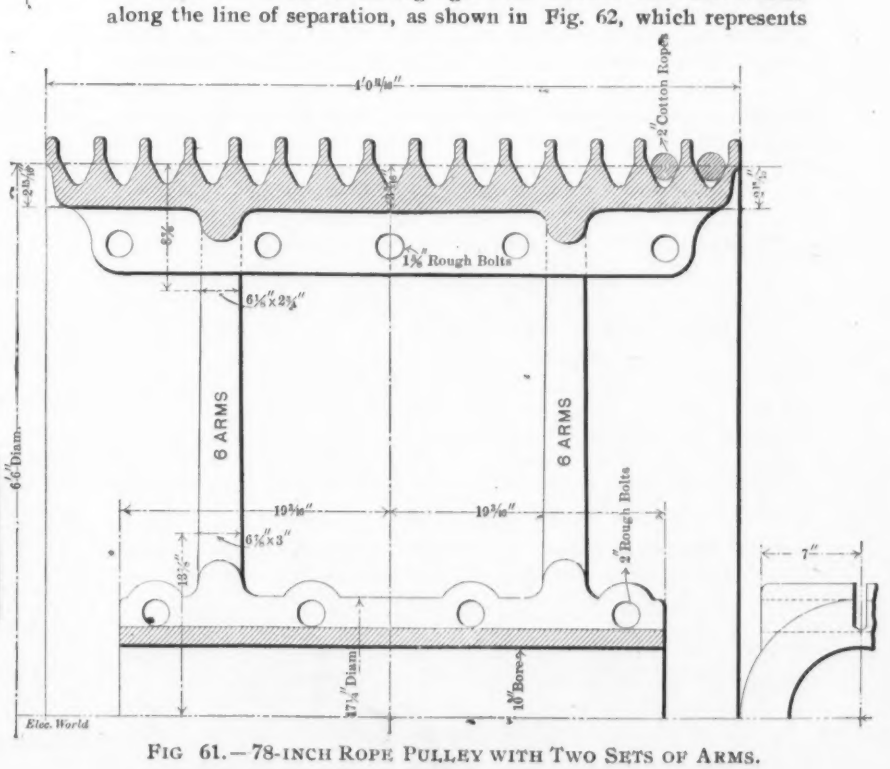


FIG. 61.—78-INCH ROPE PULLEY WITH TWO SETS OF ARMS.

a form of split pulley made by Fairbanks, Morse & Co. This prevents undue bending action, and is otherwise the better able to resist the effect of centrifugal force due to the added weight at the point of connection.

For diameters ranging from 15 feet to 20 feet the usual practice is to make the pulley in six or eight segments with as many arms, although some makers prefer ten segments; from 20 to 26 feet ten segments are usually adopted. For wheels from about 26 to 32 feet,

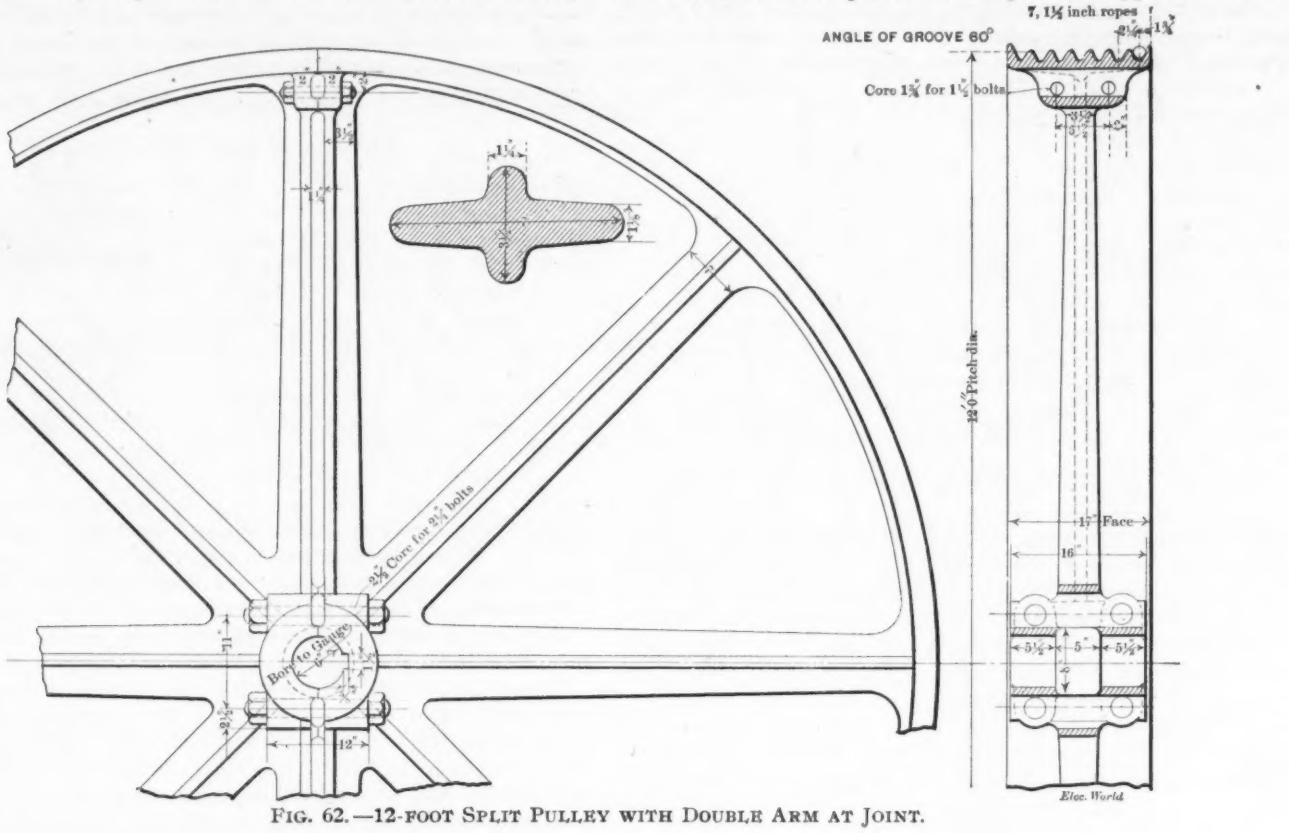


Fig. 62.—12-foot Split Pulley with Double Arm at Joint.

12 segments and as many arms are generally used, while larger-sized wheels are built up of 14, 16 and even more segments—sometimes as many as 24 being employed.*

When rope pulleys are made in halves or are built up it is important that the connecting bolts and flanges in the rim should be strong enough to resist the maximum stresses that may occur in the joint.

Ordinarily in rope pulleys the net section of bolt area is about 12 per cent. of the section at the joint, but this ranges from 25 per cent. to about 6 per cent. in different cases. Various shop rules are used by designers for obtaining the bolt section, many of which give the bolt area directly in terms of the cross-section of the rim. While such formulas may give satisfactory results for an assumed average rim speed, it is better to design the joint in large wheels from a consideration of the particular conditions in each case.

In very slow-moving, heavy wheels the principal stress may be that due to the weight of the wheel itself, but in rope pulleys and fly-wheels the rim has usually a high velocity and the strain due to centrifugal force in the rim is the principal factor in determining the bolt section; it is obvious, however, that in high-speed heavy wheels both influences should be taken into consideration.

The tension in the rim produced by centrifugal force is equal to one half the centrifugal force due to the weight and velocity of the rim multiplied by the ratio of diameter to semi-circumference or equal to

$$\frac{F_0}{2} \times \frac{2r}{\pi r} = \frac{F_0}{\pi};$$

as this force is resisted at each end of a diameter, the strain T_h or hoop tension acting at either end, will be one half the above, hence

$$T_h = \tfrac{1}{2} \frac{F_0}{\pi}$$

in which F_0 has the usual value $0.00034\ W R N^2$,

where W = entire weight of rim,
R = effective radius of rim in feet.
N = revolutions of wheel per minute.

The tension at each end of a diameter due to the weight of the rim is evidently equal to $\tfrac{1}{2}\left(\frac{W}{2}\right)$ therefore the stress in the rim due to F_0 and W will be:

$$S = \tfrac{1}{2}\left(\frac{F_0}{\pi}\right) + \tfrac{1}{2}\left(\frac{W}{2}\right) = \tfrac{1}{2}\left(\frac{F_0}{\pi} + \frac{W}{2}\right).$$

If the bolts could be placed at the point of application of this force, their effective section A would be $\frac{S}{f}$, where f is the allowable stress in the bolts.

(To be continued.)

* *American Machinist*, Feb. 16, 1893.

Maxwell and Joubert.

To the Editor of The Electrical World:

Sir:—The letter of Dr. Pupin in The Electrical World of May 11, in which he criticises the passage in the biography of Prof. Joubert where I attribute to the latter the discovery of the law of alternating currents, seems to me to be due to a misapprehension and one easy to dissipate.

Every one knows, of course, that the study of induced currents had been theoretically made long ago by Maxwell, whom, besides, I cited. Kohlrausch had invented his sine-inductor as early, I believe, as 1869, and a search through the memoirs of Weber would probably bring to light still earlier references. But I do not think that the merit of Prof. Joubert is thereby diminished, which merit consists (as I have said in a phrase which Dr. Pupin probably did not read), in having *discovered this law experimentally* at a period when no one thought of applying it to practical industrial currents. It is a fact which, I believe, Dr. Pupin does not contest, that in 1881, no one, even in America, knew what formulas applied to alternators, and that after the work of Prof. Joubert everything relating to this became very clear; this is what to me seems to constitute a discovery. Perhaps it would not be considered as such in the Patent Office, but from this standpoint the polyphased motor of Bailey might be a sufficient anticipation to invoke against Ferraris or Tesla in order to declare their work without value. If Dr. Pupin accepts this consequence of his method of appreciating discoveries, I can only bow to his opinion. But, in the contrary case, I believe I can claim, without "bolstering up" the glory of Prof. Joubert, that the law of alternating currents was sufficiently invented or re-invented by him to justify giving his name to it, and this without lacking a jot in the great respect inspired in all of us by the name of Maxwell.

A. Blondel.

Paris, France.

The Efficiency of the Sun's Radiations.

According to Prof. Langley's researches on Mt. Whitney the amount of energy received on the surface of the earth from the sun when it is overhead is 1.6 kilowatt per square meter; the portion of this which represents light is only 35 per cent., that is, 0.56 kilowatt,

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

BY CARL HERING

COMPILED FROM THE PRINCIPAL FOREIGN AND AMERICAN JOURNALS

Note.—The object of this department is to give a digest of the principal technical articles on electrical subjects appearing in American and foreign periodicals. The abstracts will contain, briefly, the nature of the article, its object, and the most important data or conclusions, as far as the limited space will admit. Abstracts made by the authors, editors, or publishers are solicited and should be sent to the Philadelphia office of THE ELECTRICAL WORLD, 927 Chestnut Street. They should be forwarded so as to be received at least as early as the journal in which the original articles appear; they should not be longer than the importance of the subject warrants, and must comply with the general outline given above, the compiler reserving the right to edit or reject them. Such abstracts may be sent in the English French, or German languages. It will be to the advantage of all concerned if editors of non-electrical journals, or of such electrical journals as are not regularly abstracted, will send the compiler a copy, specially marked, in which any important electrical article appears.

DYNAMOS, MOTORS AND TRANSFORMERS.

Calculation and Construction of Dynamos.—In a continuation of Mr. Picou's article in "L'Eclairage Elec.," May 11, he discusses commutators, brushes, sparking and field magnets; it appears to be somewhat elementary in character.

Brush for Low Voltage Machines.—The "Elec. Eng.," May 29, describes and illustrates Prof. Elihu Thomson's brush which is made of a number of small rods of carbon, plated with a thin film of copper, assembled in the form required and then united by soldering them together; the copper is so thin that the moment it touches the commutator the current through it disintegrates it at once, thus eating away the metal for a short distance as rapidly as the carbon wears away; the conductivity of the brush may be varied to suit the current to be taken, by increasing the thickness of the copper deposit.

Practical Hints in Dynamo Design.—The "West. Elec.," June 1, reprints from the "Bul. Univ. of Wisconsin" for May, 1894, a lecture by Mr. Wilkes; it is practical in its nature and is limited to continuous-current machines for general purposes.

Rotary Current and Alternating Dynamos.—A paper of Mr. Dobrowolsky, abstracted in the Digest, March 9 (see also April 20), is reprinted from the Lond. "Elec.," May 17, with illustrations in the "Elec. Eng.," June 5.

LIGHTS AND LIGHTING.

Train Lighting.—In the continuation of Mr. Weeks' article in the Lond. "Elec. Eng., May 24, he gives a short historical summary and begins the detailed description of the system used in England; in the present number he gives a well-illustrated description of the one used on the London, Brighton & South Coast Railway in which the dynamo is placed on the baggage car and the accumulators are either distributed on the whole train or all together in the baggage car; the dynamo is driven by means of a belt over the axle of the car; an automatic switch connects or disconnects the dynamo at the proper speeds; the E. P. S. accumulators are used and are said to last about 2¾ years but must be dismantled every 16 months and thoroughly cleaned; the E. M. F. of the dynamo rises very little with increase of speed, and no regulator is used in the exciting circuit, the dynamo being an open-coil Brush machine having a great armature reaction. The costs are given as follows: each train costs about $2,000 to equip and the working costs for maintenance and renewals for a year are $270 per train; there are now in use 36 trains of 10 and 12 coaches each and 4 main line fast trains, making a total of 410 coaches; experience has shown that these trains are more serviceable than gas lighted trains, being always ready to run and to run continuously; it is estimated that the company gets about 15 per cent. more work out of them than from gas lighted trains, thus 85 electrically lighted trains would do the work of 100 gas lighted trains.

The following data from a report of Mr. Staberow concerning the system used on the line from Dortmund, is published in the "Elek. Zeit.," May 23. The plant was installed a year ago; Tudor accumulators are used; seven cars are equipped with a total of 85 lamps; the results were satisfactory from both an engineering and a commercial standpoint; the total cost of the whole installation and equipment was about $9,000; the cost of operation per 10-cp lamp-hour was 0.68 cts. or with the addition of 4 per cent. for interest and 3 per cent. for amortization it was 1.58 cts.; with a larger installation the cost would be lower; on the Jura-Simplon railway it was only 1.03 and on the Danish railway 1.54 cts.

Employment of Electric Light for Railway Purposes.—The recent Institution paper of Mr. Langdon is published in full, with the illustration and discussion, in the "Jour. Inst. Elec. Eng." for May.

Products of Combustion of the Arc.—An abstract of the article of Mr. Grehant describing the apparatus and tests (see Digest, May 25), is given in the Lond. "Elec. Eng.," May 24.

Non-Magnetic Arc Lamp.—In the "West. Elec.," June 1, Mr. Irish describes a lamp which is governed by a thermo wire and has a screw feed.

POWER AND HEAT.

Hydro-Electric System.—According to the Lond. "Elec., " May 24, the company operating the Van Rysselberghe combined hydraulic and electric system in Antwerp, has issued its first report from which it appears that the system has not been as successful as was anticipated; there is a deficit of about $9,000; the management admits that the system cannot compete with other electrical systems. This system, in which the power is transmitted hydraulically and converted into electric energy at the local stations, was described in the Digest, Oct. 7, 1893; Feb. 24, and April 14, 1894.

Portable Electric Drill.—An illustrated description of the Kodolitsch drill is given in the Lond. "Engineering," May 24.

Regulation of Turbines.—In reply to the recent statement of Mr. Egger (see Digest, May 18), that a mechanical regulation of a turbine is an impossibility, Mr. Voith, in the "Elek. Zeit.," May 23, states that he has installed several such regulators which are very satisfactory; he describes one of these installations.

Possibilities of Electrical Pumping Machinery.—In a recent paper by Mr. Hague, abstracted in "Eng. News," May 30, he shows the advantages and economy of utilizing electrically driven pumps for supplying water to portions of a city where a high-pressure service is required over a limited area and for a comparatively small percentage of the total water supply of the city; as an illustration for a large city, he shows that about 500 hp would be required if the whole city were supplied with a high-pressure system, while if the divided system were used, one tenth of the supply being required for the high-pressure district, the economy of power would be 210 hp. The main pumping plant would be used to generate the current and the electric pump would be placed locally where the high pressure is required; power could also be obtained from existing street railway or lighting plants; the current might readily be switched on and off automatically.

Electric Motors in Sugar Refineries.—The "West. Elec.," June 1, abstracts briefly from a German journal an article by Mr. Kohler showing the economy in the introduction of electric motors in a sugar refinery; an elevator formerly run by steam required 32.5 hp-hours per day while run by electric motors it required but 17.6.

Slavianoff Welding System.— The "West. Elec.," June 8, publishes a number of illustrations of repairs of large pieces of machinery made by this system; among them is a large bell, a shaft, some large wheels and a large roller for a rolling mill; the system was described in the Digest, April 6.

Electric Heater.—A novel form of heater devised by Mr. Reed is described and illustrated in the "Elec. Eng.," June 5; it consists of a glass or porcelain tube on the interior of which is a thin film of silver deposited in the same way as in the silvering of mirrors; on account of its extreme thinness its resistance is high; the conductor is thoroughly protected, is not exposed to the air and has a very large heating surface.

TRACTION.

Side Trolley Wire System.—In a communication in the Lond. "Elec. Eng.," May 24, Mr. Owen gives briefly some of the advantages of the system used in South Staffordshire in which the trolley wire is over the side of the street.

Car Wire and Equipment.—In Mr. Dawson's serial in Lond. "Engineering," May 24, he describes and gives good illustrations of the car wiring and equipment.

Electricity for Marine Propulsion.—"Cassier's Mag." for June, contains an interesting article by Prof. Durand in which he compares, in detail, electricity with steam for marine propulsion, with reference to the weight, volume and cost. In considering electrical propulsion he assumed that it would take 100 pounds of accumulators to generate

1 hp or 125 pounds for 1 hp at the shaft; this occupies one cubic foot of space; he finds that for equal amounts of energy embodied, storage batteries weigh about 550 times as much as coal and occupy about 220 times as much space; for equal amounts of work on the shaft, batteries weigh about 40 times as much as coal and occupy about 16 times as much space; for the same power developed electric motors weigh considerably less than steam engines while the space occupied is so small that it is practically negligible when compared with boilers, engines and auxiliaries; for equal amounts of energy embodied the cost of charging batteries is about 100 times the cost of coal; for equal amounts of work on the shaft the cost of charging the batteries is about seven times that of coal; for equal amounts of work on the shaft, electric propulsion would require an initial consumption of twice as much coal as with steam propulsion; for equal power on the shaft electric motors will cost nearly as much as the total steam machinery (?); he discusses the elements of weight algebraically and shows the limitations; the most favorable comparison for electrical machinery he shows to be on a basis of about 8 hours service and in such cases the electrical machinery would weigh about 5 times as much as the equivalent steam machinery and coal; in first cost electrical machinery will be much more expensive. In conclusion he points out the well-known advantages of electrical propulsion which under certain circumstances far outweigh its disadvantages; electrical propulsion cannot compete with steam for either high speed or long runs; for a transatlantic steamship of 15,000 tons displacement, 20,000 shaft-hp and 7 days supply, the weight for the steam machinery would be about 4,400 tons and for electric machinery 150,000 tons or about 10 times the total displacement of the vessel.

Electric Launch.—An illustrated description of the Hickley double-screw launch is published in the "Elec. Eng.," June 5.

Interurban Electric Railway.—The "Elec. Eng.," May 29, reprints in abstract a recent paper by Prof. Short read at the Cleveland Electric Club; he discusses the various points developed in this new branch of travel from the standpoint of a practical engineer; several tables are reproduced, of the performance of 50 and 100-hp motors; the advantages of continuous-current rotary transformers are discussed and a good illustration of a Walker interurban train is given.

Method of Locating Faults in Electric Railways.—Mr. Henry's system is briefly described in the "Elec. Eng.," June 5; a supplemental overhead, insulated, return conductor, run along the tops of the poles is divided into sections each of which is connected to the track and so arranged that an ammeter may be inserted between the sections or in the connection to the track, in order to measure the current in that wire; it has a comparatively high resistance but on the occurrence of a fault in the track an increased current will pass through this supplemental wire around the fault; the readings of a portable ammeter conveniently arranged for insertion in this circuit will then locate the fault.

Limit of Passenger Capacity of a Suburban Track.—A discussion by Mr. Von Emperger is reprinted in the "Elec. Rev.," June 5, from the "Railroad Gazette." He shows that the highest permissible capacity of the whole proposed rapid transit road in New York City below Fourteenth Street, consisting of two tracks, would be 28,000 passengers of which 10,000 would have no seats; as the Rapid Transit Commission claim that 60,000 can be carried an hour by one track, its claim should not go unchallenged.

Electric Car Heating.—The "Eng. Mag." for June states that according to the "R. R. Gaz.," March 22, steam heating costs per car-hour 3.75 cts. with coal at $4.50 per ton, while heating by electricity costs 10.7 cts. or a little more than three times as much; the estimate is said to have been made with perfect fairness to electrical heating and all details are said to have been carefully considered.

Legislation on Steam and Electric Roads.—An abstract of a paper by Mr. Woodruff, read at the Washington convention of railroad commissioners, is published in the "Elec Eng.," May 29.

Boston Subway.—A long, well-illustrated description referring almost entirely to the civil engineering features, is published in the "Eng. News," May 30.

Street Railway Mail Car.—A brief, illustrated description of the one used in Chicago, is published in the "West. Elec.," June 1.

Columbus.—The water power plant for the Columbus, Ga., electric railway is briefly described and illustrated in the "Elec. Eng.," May 29.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Accumulators in Central Stations.—A recent paper by Mr. Howell on "Uses of Accumulators" is reprinted in full with the exception of the illustrations, in the Lond. "Elec. Eng.," May 24, and is begun in the Loud. "Elec. Rev."; he limits himself to showing the advantages of using accumulators in central stations; the first portion gives a history of the use of accumulators. He gives a table of the efficiencies of a steam-driven dynamo at various loads, showing that the quantity of water evaporated per unit when the engine is working at 20 per cent. of its full load is more than twice as much as when it is fully loaded; in another table he gives the results of some tests of Prof. Kennedy showing the coal consumption at various loads and among other things showing that there was less coal burned during the period of lighter load and that 63 per cent. of the total amount of fuel consumed was used to provide 33 per cent. of the output; from this it is seen that if there had been a means of storage which would have allowed the engines to run at a fair rate of economy there would have been a saving of coal. To show the advantages in the use of accumulators he takes as an illustration a large American station having a maximum output of 18,800 amperes which is at present running without accumulators, and points, out what the gain would be if accumulators were added (in this connection he refers to diagrams and curves which are not given but which will probably be published in the next number of the "Elec. Rev."); from the minimum demand and the time during which it lasts he determines the capacity of the accumulators which he finds must be 14,000 ampere-hours; the accumulators will cost $35,000 delivered and erected; whenever an engine is started it can then be run at full load from the minute it starts to the moment it ceases running, thus bringing the efficiency of the station to 100 per cent. engine load factor; the hours of running will be shortened from 24 to 18; three large sets would be started with full load at 7 a.m. and run steadily throughout the day; the peak of the load line would be supplied by the battery. He states that the regulation of the charging current is an exceedingly simple matter; one of the steam dynamos would be expressly made to give just the current rate necessary for properly charging the battery and no more; the loss in the accumulators is very slight as it is felt only by one unit of the plant, and on the load diagram under discussion it would be only 1 per cent. of the total load delivered to the circuit, the accumulators supplying about 8 per cent. of the total output. He then shows what has been gained by the introduction of accumulators; the station work will be immensely simplified; the labor bill will be considerably reduced; he gives the latter in detail showing a saving of almost $9 per day; the coal will be reduced from 80 to 67 tons per day and the bill for oil and petty stores in about the same proportion; three engines that are required now can then be abandoned altogether; the total saving is $75 per day; against this there is $10 a day for depreciation of accumulators and $5 for interest, thus reducing the net saving to $60 per day, which is sufficient to cancel the cost of the accumulators in two years; he has taken for this illustration a very large station showing that the statement that the use of accumulators is limited to small stations, is incorrect; the economy is sufficiently marked at any value of coal, to warrant the adoption of accumulators; he concludes that wherever there exists an intermittent demand for a supply of electricity a storage system is a necessity unless the cost of initial power is abnormally low, which sometimes occurs when there is an abundant supply of water power; to obtain the utmost economy, accumulators are absolutely necessary; he also believes that they will surely be used in the near future in mining work, the batteries being installed in the mines.

Electric Lighting in Small Towns.—In its leading editorial the Lond. "Elec. Rev.," May 24, suggests a plan for supplying small towns and villages with light and power, which it believes can be carried out successfully. In such towns central stations will never succeed as long as each is a distinct concern, and it therefore suggests that the owners of the installation in a large central town install independent plants in the smaller towns in the neighborhood, which plants are controlled by them from the large town as centre; two or more units would be installed in each town and one or more banks of accumulators for supplying the day load; one man and a boy would be sufficient to take charge of each station and the engineer of the central town station would have control of all the small plants; a portion of the officers' salaries and other incidental expenses would be charged to each of the small stations, thus relieving them of the heavy management expenses. It gives the operating expenses of a small plant showing a revenue of 7.5 per cent. on the capital outlay; continuous current is used in connection with storage batteries; regarding the use of alternating currents for this purpose it believes that the risks to which the town would be exposed, due to some failure of the lines, would be too great.

Variations of Electric Pressure in London.—The Lond. "Elec.," May 24, published a set of diagrams prepared by Mr. Swinton, giving the voltage during the period of one whole day, of each of the stations in London; the records were made with a Holden form of hot-wire recording voltmeter which is exceedingly sensitive and very dead beat; the records were taken at the consumers' end of the system. In many cases the variation from the correct voltage is considerable; as far as the fluctuations from the average are concerned, there is not much to choose between the alternating and the continuous current systems; in the latter there is a tendency for the average volts to be below the correct value, while with the former it is the other way, the average being very considerably higher than it should be; where the supply is from accumulators during some portions of the day it is well indicated by the smoothness of the curve.

Electric Heating and the Day Load.—Mr. Jenkinson, in a correspondence to the Lond. "Elec. Rev.," May 24, calls attention to the use of separate meters, if the day load is to be charged for at a different rate, and states that Mr. Wright's system at Brighton avoids this, the current all passing through one meter, the reduction to six cts. per unit for all purposes taking place after the maximum current has passed for one hour per day; he believes this to be as nearly perfect a system as any that he has seen.

Association for Controlling Electric Installations.—The Lond. "Elec.," May 24, published a translation of the objects, rules and regulations of the "Bureau de Controle des Installations Electriques." This association, which was started in Paris about two years ago by the electric supply companies, is free from any commercial connections and has for its object the inspection of electric lighting installations, and the testing of meters belonging to companies and private concerns, and provides to its customers all the desired information concerning the safe operation of their installations. Of the 101 installations inspected during the first year 62 were reported as being defective and of the 168 inspected in the second year 148 were defective; about one third of the meters tested were defective. The organization of such a society in England is discussed editorially; a description of the method used for testing the meters and the insulation of installations, is promised in a future article.

Rules and Regulations for Installations.—The "Elek. Zeit.," May 23, publishes in full the proposed set of rules for installations in Germany, which were prepared by a joint commission of the Union of German Electricians and the German Electrical Society; a brief abstract giving some of the most important points is published in the Lond. "Elec.," May 24. (As these rules are to be acted upon at the annual meeting of one of the societies in July, our abstract will be postponed until after they have been finally adopted.)

Budapest.—The long report on this station by Prof. Kittler is concluded in the "Elek. Zeit.," May 23; it gives in detail the results of a very elaborate test.

Hong-Kong.—An illustrated description of this alternating-current station, which has been running for over five years, is published in the Lond. "Elec. Eng.," May 24.

Polycyclic System.—A brief description of this system devised by Mr. Steinmetz, is published in the "Elec. Eng.," May 29; it is specially designed to avoid unbalancing of the system when motors and lights are both supplied from the same circuits; the lights are all on one of the three branches and the energy is transferred "between this branch and the other branches through one of the motor coils"; the motors receive power currents of two phases between the other branches of the system; there will be "substantially a balance between the counter E. M. F. generated in the circuit of the motor coil (which corresponds to the branch containing the lights) and the impressed E. M. F. in the lighting circuit. Whenever this relation becomes distributed, as for example by changing the lamp load and so changing the voltage in the lighting circuit, the balance is restored by current flowing through that coil of the motor and which may help out either the lamps or motors as conditions require."

Power, Light and Heat in City Blocks.—In a short article by Mr. Talbot, in the "Eng. Mag." for June, he points out the advantages and economy of supplying power, light and heat to a city block or "square" from a small central station erected in one of the large buildings; as such a building would probably install a plant of its own it would require only an enlargement of it to supply the whole block.

Central Station Practice.—A lecture by Mr. Greene on "Some Suggestions on Central Station Practice with Special Reference to Developments During the Past Year" is published in "Sibley Jour." for May; he discusses first the original investments and secondly the operating expenses of the plant.

Methods of Storage Battery Installation.—The "Elec. Eng.," June 5, reprints from a new catalogue of the Electric Storage Battery Company (makers of "chloride" accumulators) several diagrams showing various methods of connecting batteries with the necessary apparatus to form a complete plant.

Pennock Electric System.—The article of Mr. Swann, abstracted in the Digest, June 8, is reprinted in "El'ty," June 5.

Belfast.—Some of the illustrations of the article published in THE ELECTRICAL WORLD, May 18, of this gas engine and accumulator station are reprinted in the "West. Elec.," June 1.

Private Plants.—The Siemens & Halske plant in the Boston new public library is described and illustrated in the "Elec. Eng.," June 5.

ELECTRO-PHYSICS AND MAGNETISM.

Conductivity.—An article by Prof. Strecker from the "Wied. Ann.," 1895, p. 434, is abstracted briefly in the "Zeit. f. Electrochem.," May 20. He finds a contradiction in the modern views concerning conductivity; in a metallic conductor it is said to be the property to receive electric energy from the ether and convert it into molecular energy; in electrolytes, on the other hand, electricity is said to be something which is connected with the smallest particles of matter and travels through the liquid by being transferred from particle to particle; he thinks that the same explanation should apply to both cases and he, therefore, suggests that the first one, regarding metallic conductivity, be applied also to electrolytic conductivity and that it is the ions and not the molecules which should be considered; by the movement of the ions caused by the current there is an action between the ion particles and the ether at the moment when the energy passes from one to the other.

Influence of Electric Waves on the Resistance of Conductors.—A paper by Mr. Aschkinass from the German is abstracted in "L'Eclairage Elec.," May 11; he found that the resistance diminished notably by the action of electric waves and that the diminution lasted for several days without sensible variation, its maximum value being about 2 per cent., which was reached after the passage of the first spark; on heating, the resistance again rises to its original value.

Atmospheric Electricity.—The Lond. "Elec.," May 24, begins a reprint of an interesting lecture by Prof. Schuster and comments on it in the leading editorial.

Alternating and Interrupted Currents.—The first part of the third lecture of Prof. Forbes, is published in the Lond. "Elec. Eng.," May 24. He discusses skin resistance, resonance and oscillations.

Electric Dispersion.—An article by Mr. Drude from the "Wied. Ann." for February is abstracted in "L'Eclairage Elec.," May 11.

Magnetism and Weather.—The Lond. "Elec. Rev.," May 24, calls attention to a paper by Mr. Hasen in "Science," Vol. 1, No. 9, in which he states that after 13 years of study he is satisfied that the pressure of the air, or perhaps the fluctuation of the dew point, are by far the best means to use in determining a possible connection between magnetism and the weather; such a relation if it exists would be found to be only an indirect one; a connection has certainly been found with auroras, and facts warrant the assumption that the diurnal range of air pressure is a thermo-electric phenomenon allied to the diurnal range in the swings of a magnetic needle; but up to date very little positive knowledge exists.

Magnetic Shielding.—The Lond. "Elec. Rev.," May 24, calls attention to a paper by Mr. Ascoli in the "Wied. Ann.," 54, p. 381, in which he objects to the idea of screening, arguing that the effects are more properly explained as being the result of the different specific resistances; he considers that it is a misuse of terms to speak of a sheet as screening a medium having a permeability similar to its own. The editorial expresses the belief that the subject has not yet been fully investigated.

Electric Discharges.—The Lond. "Elec. Rev.," May 24, begins the publication of an abstract of a recent Royal Society lecture by Lord Armstrong and reproduces some very interesting and exceptionally fine photographs and dust figures produced by the action of very powerful electric discharges; those interested will do well to study these figures. Most of the effects were obtained by the use of a large multiple Wimshurst machine capable of giving a 17.5-inch spark; the photographs were obtained by the well-known method of causing the discharge to pass over the surface of a photographic plate; the dust figures were produced by discharging on glass or metal plates over which had been sifted various more or less non-conductive powders such as calcined magnesia mixed with lampblack, or tripoli powder and pulverized carbon; many of the results are said to be quite inexplicable and, therefore, of great interest to the electrical theorist. The well-known experiment of Lord Armstrong with a thread of cotton connecting two glasses of water (see Digest, March 18, 1893), is also described.

ELECTRO-CHEMISTRY AND BATTERIES.

Electrolysis of Hydrochloric Acid without a Diaphragm.—In a short article by Dr. Oettel in the "Zeit. f. Electrochem.," May 20, he shows that the efficiency in the production of chlorine is very low but that if one uses a concentrated solution of salt mixed with sulphuric acid there is less tendency for the chlorine to dissolve and the efficiency in the yield of chlorine would therefore be higher; even with as low a density as 240 amperes per square metre the efficiency will be 70 per cent. and with 600 to 700 it will be 92 to 98 per cent.; if there is too much sulphuric acid there will be a tendency to produce oxygen with the chlorine, and if there is an excess of salt the evolution of gas on the anode will cease almost completely; the output, voltage and efficiency are given in the form of curves.

Conductivities of Solutions of Salts in Acetone.—The "Zeit f. Electrochem." May 20, contains a short article by Mr. Von Laszczymski in which he gives the results of conductivity determinations of a number of salts; the conductivities are much worse than those of the solutions in water; he also gives the results of the electrolysis of these solutions.

Tests of Electrolytic Copper Tubes.—Results of some tests of Prof. Unwin, with copper tubes made by the Elmore process, are published in Lond. "Engineering," May 24; they show that the material possesses a high ratio of elastic limit to ultimate strength.

Electrometallurgy of Gold.—According to the Lond. "Elec. Rev.," May 24, Mr. Goyder in investigating the action of potassium cyanide, noticed that the presence of oxygen is required to effect the solution of gold, that such solutions deposit their metallic contents when electrolyzed while the potassium cyanide gradually undergoes decomposition into potassium and ammonium carbonates and that if the current is broken the gold redissolves. Attention is also called to a new method proposed by Mr. Lossen described in the "Ber. Deutsch. Chem. Gesell.," 27, p. 2726, (abstracted in Digest, May 4); he electrolyzes a solution of potassium bromide and obtains an alkaline solution which contains hypobromite and bromate which is capable of dissolving gold; the ore is treated with an excess of this solution in rotating cylinders, after filtra-

tion the gold is precipitated by iron and coal and the solution is then electrolyzed and used over again.

Electrolysis of Gold.—The recent Institution paper of Dr. Keith is published in full with illustration and discussion in the "Jour. Inst. Elec. Eng." for May.

Electrometallurgy of Zinc.—A brief description of a plant in Germany is published in the Lond. "Elec.," May 24. Pyrites containing a large proportion of zinc are first used for the production of sulphuric acid, the residue is then lixiviated, roasted with salt to obtain the purple iron ore and the residue of this after being again lixiviated is electrolyzed, yielding zinc from the lye; the zinc is said to be much purer than the best hitherto obtainable and commands a high price; the works have been in operation only a few months and at present yield three tons of zinc a day; when completed they will yield 12 tons per day; no further information regarding the process is given.

Primary Batteries.—Descriptions of several forms, taken from patent specifications, are given in the "Zeit. f. Electrochem.," May 20; among others, is a small primary battery placed in the end of a cane, and sufficient for lighting a small lamp; it is said to yield three amperes at 12 volts (for how long is not stated).

Secondary Batteries.—"L'Eclairage Elec.," May 11, contains an article by Mr. Poincaré on "A Class of Secondary Cells"; it appears to be practically the same article, a translation of which was abstracted in the Digest, April 27.

Accumulator Patent.—According to the Lond. "Elec.," May 24, the Swan British patent No. 2,272, May 24, 1881, legally expired in England May 24, 1895.

Maximum Possible Efficiencies of Galvanic Batteries.—"Cassier's Mag." for June contains a short article by Dr. Morton, in which he shows the theoretical maximum output or the minimum consumption of zinc, of different kinds of batteries, limiting himself to those which long experience has proved to be the most efficient for supplying large currents. In all these the energy is derived from the combination of zinc with sulphuric acid; the oxidation of one pound of zinc generates 2,340 British thermal units (lb. Fah. heat units) and the solution of the oxide in dilute sulphuric acid generates 666 more or in all 3,006 units; no arrangement of parts or employment of other materials in other parts of the cells can add anything to this, while some must always be subtracted; the hydrogen generated must be taken care of, which will require energy; subtracting this gives the following figures of the useful heat units generated; in the Smee 900, Daniell 1,419, Grove or Bunsen 2,722.4, Poggendorff or chromic acid 2,827.5; these figures represent the absolute maxima of energy which a pound of zinc can develop excluding all losses from resistance, etc.; he reduces this to foot-pounds and to horse-powers for one minute; the matter are: Smee 21.05, Daniell 33.19, Grove 63.66, Poggendorff 68.57; they show that in the best forms of battery an allowance of one horse-power for each pound of zinc consumed per hour would be a liberal one if something is allowed for resistance, etc.; he shows that no great improvement over the Poggendorff battery is possible, as the figure for it corresponds to 1 1-7 hp per hour, while the absolute maximum that could be reached would be 1 1-6 hp; if anyone claims to obtain more than this there is certainly some mistake or fraud.

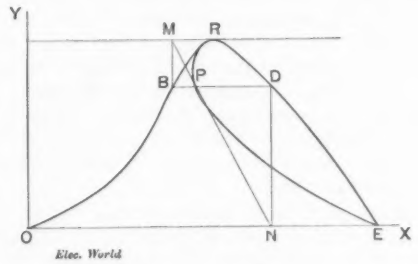
Studies on the Voltaic Cell.—"Tech. Quart." for December published a translation of a very long article by Dr. Goodwin, from the "Zeit. f. Phys. Chem." 13, 577, 1894; it deals with the fundamental question as to what energy-transformation takes place when a metal and a liquid are brought in contact, and he formulates a theory by which the voltage thus generated can be calculated from other measurable physical quantities; he refers to the osmotic theory of Prof. Nernst and describes experiments suggested by Prof. Ostwald for testing the generalization of the theory; he reviews and formulates the fundamental ideas on which the theory rests.

Multivolt Battery.—Prof. Anthony in the Lond. "Elec. Eng." May 29, shows that there must be considerable waste from local action in the Boynton battery recently described in the electrical journals, as the three cells are in the same liquid and there will therefore be local currents from one cell to the other through the liquid, which currents represent waste; he believes that this current is not negligable and suggests that it would be much better to have each cell in a separate jar.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Iodine Voltameter.—A Physical Society paper by Mr. Herroun is abstracted in the Lond. "Elec." and "Elec. Eng.," May 24. (After discussing the usual methods for determining the values of small currents, and discussing the errors, he gives his reasons for selecting iodine; with the exception of mercury in the mercurious state iodine has the largest electrochemical equivalent, and by titration (volumetric method) with sodium thiosulphate it is possible to determine the quantity of iodine liberated to a greater degree of accuracy than is possible by weighing a deposit of copper or silver with a balance; (the balance must, however, be used in making the solution used in titration). The solution used in the voltameter contains 10 to 15 per cent. of zinc iodide; the solution may be kept some time without liberating free iodine, by introducing a small piece of metallic zinc in the solution and it should not be exposed to a strong light; the anode consists of a plate of platinum at the bottom of a tall and fairly narrow beaker; the wire for the anode is encased in a glass tube so that the iodine is liberated only at the bottom where it tends to collect; the cathode consists of an amalgamated zinc rod enclosed in filter paper or vegetable parchment; during two hours' use none of the iodine will diffuse to the part of the solution near the zinc cathode but if the action lasts longer, a U-tube is used with two small plugs of asbestos at the bend, which form may be used for tests lasting several days. On account of the production of electric convection currents this apparatus is not as suitable for the accurate measurement of strong currents; after the current is stopped the zinc is immediately removed, the solution stirred and the amount of iodine liberated is determined by titration with sodium thiosulphate; a convenient strength of the latter solution is one in which one cu. cm corresponds to the amount of iodine liberated by five coulombs of electricity; this solution contains 12.8375 grams of pure re-crystallized sodium thiosulphate per litre; it is possible to perform the titration to within 0.1 cu. cm which corresponds to 0.5 coulomb or in one hour to 1-7,200th of an ampere; in a comparison made with a silver voltameter a difference of somewhat less than 2 per cent. was found, part of which the author believes was due to the effect of oxygen dissolved in the solution of silver nitrate. (No further description of the apparatus or method is given in the abstract from which this is taken.) In the discussion which followed Prof. Foster considered this method a most valuable one, believing the application of the volumetric method to be new; he did not see the advantage of using a substance with a high electrochemical equivalent if a volumetric method was used; Mr. Enright stated that he had used porous diaphragms in iodine voltameters and found that the iodine collected in the positive department while the water was driven into the negative one; with strong currents it was possible to get almost pure iodine in one compartment; Mr. Watson thought that the difference between the silver and iodine voltameters could hardly be due to the cause suggested; Mr. Elder warned the members that volumetric measurements were not as accurate nor as easy as they seemed to be and he particularly mistrusted a solution of sodium thiosulphate as he found that it changed even in 24 hours; the difficulty of accurately reading the burette might be overcome by weighing it before and after the measurements; the author in his reply stated that the electrodes he used had about nine square cm surface and that with this 0.1 amperes was the maximum current it was safe to use; the only substance, likely to be produced by too great a current density was periodate, which, being insoluble, would immediately be noticed; in the silver voltameter the influence of the dissolved oxygen was appreciable only with small currents lasting some time; in conclusion the chairman, Captain Abney, stated that he found zinc salts to be very untrustworthy.

Graphical Method of Finding Mean-Square Values.—The following methods are described by Mr. Russell in the Lond. "Elec.," May 24. In the adjoining cut let *O R E* be the curve the ordinates of which are



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the values of the varying quantities; draw a series of lines like *B D*, parallel to *O X*; draw perpendiculars *B M*, *D N* and the diagonal *M N* marking the point *P* where *M N* intersects *B D*; find similar points like *P* and draw *R P E* passing through all these points; measure *h* the maximum height of the curve, *l* the length of the base *O E* and *A* the area of the curve *R P E D*, then the mean value of the squares of the ordinates is equal to

$$2\frac{h}{l}A.$$

A mathematical proof of the method is given. The second method is as follows: find the area *a* of the curve *O R E O* and the position of its centre gravity, by the well-known experimental methods; measure the height *y* of the centre of gravity above the base and the breadth *l* of the curve (presumably *O E*), then the mean square of the heights of the curve is equal to

$$2\frac{y}{l}a.$$

A New Method of Harmonic Analysis.—A Physical Society paper by Mr. Sharp is abstracted briefly in the Lond. "Elec." and "Elec. Eng.," May 24; he "applies the principle of the form of harmonic analyzer for giving direct readings of the amplitude and epoch of the various constituent harmonic terms, previously described by him, to the performance of harmonic analysis without the use of an instrument."

Determination of Dielectric Constants.—The method of Mr. Nernst mentioned in the Digest, Dec. 29 last and Jan. 19, is described briefly in the Lond. "Elec. Rev.," May 24.

Determination of the Potential of the Atmosphere on the Eiffel Tower.—A Physical Society paper by Mr. Chauveau, briefly describing the method and apparatus, is published in "L'Eclairage Elec.," May 11.

Resistance of Solutions of Sugar.—A short Academy paper by Messrs. Gin and Leleux giving the results in the form of formulas is reprinted in "L'Eclairage Elec.," May 11.

Submarine Cable Testing.—In his serial in the Lond. "Elec.," May 24, Mr. Wilkinson described Kennelly's modification of the Mance test for fracture.

Hot Wire Device.—The "Elec. Eng.," May 29, contains a number of communications and some articles referring to the suggestions and statements in the recent article of Mr. Irish, abstracted in the Digest, May 18. In a article by Prof. Stine on "Electrical-thermo Devices" he shows that although the hot wire is in general an inferior device when compared with an electromagnet, there are cases in which it can be used to advantage; he discusses several of the applications; for galvanometers it offers advantages for limited uses; he believes that it could be developed into a fairly sensitive galvanometer for portable work and, though dead beat, its sensitiveness is lower than that of the better types of galvanometers; he has in use one whose figure of merit reduced to an ordinary rating is 0.0001 and he believes it possible to construct one which is at least 1,000 times as sensitive. He thinks the difficulties connected with its application to ammeters, voltmeters and indicators, can be overcome, and that accurate and durable instruments can be constructed although the complexity and the cost are against it; regarding the merits and faults he believes that the latter greatly preponderate, and he does not think such instruments likely to ever come into general use. Regarding arc lamps he believes the thermo principle offers many advantages, the feeding being gradual and uniform; such lamps show a curve which closely approximates a straight line and on this basis it would seem that this principle should be exclusively employed; "in a few cases electromagnetic feeding of the carbons has been attempted but the results have been far from satisfactory; in use, however, the thermo lamps invariably break down and they are affected by extreme heat and cold."

Mr. Sheldon discusses the thermo device unfavorably and states that it would be unwise to rely upon an accuracy of the ratio between the length and current within 5 per cent. Mr. Lundell states that a number of years ago he used the device for moving the brushes of an arc light machine, but was so disgusted with its sluggish and freaky performances that he abandoned it. Prof. Anthony criticises the original article unfavorably, calling attention to some of the faults of such apparatus, intimating that there is little new in Mr. Irish's suggestion, and suggesting that it would have been well to have described how the difficulties which others have met with have been overcome.

Zero-Torque Meter.—The description of this meter, which was abstracted in the Digest last week, is reprinted, with illustrations, in the "Elec. Rev.," June 5.

Specifications of the Legal Ampere and Volt.—Those drawn up by the National Academy of Sciences by direction of Congress, are reprinted in full in the "Elec. Eng.," June 5; the original was mentioned in the Digest, April 13.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telegraphy by Induction.—An abstract of a recent address by Mr. Preece is published in the Lond. "Elec. Eng.," May 24; after describing induction telegraphy in general he gives a detailed description of the system which was used on the Island of Mull the cable to which was recently broken and it was decided, while waiting for the arrival of the new one, to establish connection by this means; the width of the channel varied from 1¼ to 2 miles and there existed an overhead wire on the island; a gutta-percha insulated wire was laid along the ground on the mainland for a distance of 1.5 miles, being earthed at both ends; 156 messages were sent during a period of four days and the result was very satisfactory. In conclusion he states that there is no reason why it should not be possible to duplicate and quadruplicate the messages; each particular circuit has its own sympathetic frequency and each telephone responded more energetically to one particular note than to any other, which two facts could be taken advantage of.

Currents in Cables Used with Hughes Apparatus.—An article by Messrs. Breisig and Bokelmann describing researches to determine the currents in cables which are used with the Hughes apparatus, is begun in the "Elek. Zeit.," May 23; the method used for measuring these rapidly varying currents is said to be a very accurate one and the apparatus is entirely independent of the inertia of its parts.

Railroad Telegraphy and Telephony in Switzerland.—Some statistics for the year 1893 are published in the "Elek. Zeit.," May 23.

Telephone System in the Arlberg Tunnel.—A description of this system is given briefly in the "Elek. Zeit.," May 23; extraordinary difficulties were encountered owing to the combined action of the moisture and the products of combustion from the locomotives.

Installation of Calling Batteries at the Paris Telephone Station.—An illustrated description by Mr. Montillot is published in "L'Elec.," May 25; the installation is that at the large Gutenberg station in Paris.

New Indicator Movement.—Illustrated descriptions of the system described in the Digest, April 27, of the annunciator which will indicate three different signals, are published in the London journals May 24.

Telegraphing Without Wires.—Prof. Dolbear, in the "Elec. Eng.," May 29, shows that the method which has lately been employed so successfully in England across bodies of water with no conducting cable, was fully described by Prof. Trowbridge in 1880 in the "Proc. Amer. Acad. Arts and Sciences"; he made his original researches between Cambridge and the city of Boston; a telephone was connected to a wire 500 or 600 feet long, parallel with the original circuit and grounded at both ends; he quotes briefly from the original publication.

Mexican Government Telegraph Service.—The "Elec. Eng.," May 29, contains a descriptive article by Mr. Guy, including some statistics, and a description of the zone system of rates.

Non-Inductive Telephone System.—The Marshall system is described and illustrated in the "Elec. Eng.," June 5; in this system the metallic circuit with its accompanying expensive adjuncts is not necessary; direct current transmission is used without an induction coil in the transmitter; the receiver is provided with two coils wound in opposite directions, one connected to earth and line and the other to earth and line through a condenser; the induced currents on the line are divided, half passing through the condenser and half through the other coil and thus have no effect on the diaphragm, while the direct current signals coming in on the line cannot pass through the condenser and therefore traverse only one coil and reproduce the signals; the batteries are all located at the central station, and it is claimed that one third the usual number of cells are required.

Telephone Transmitter Without Electrodes.—The Cottrell device is illustrated diagrammatically and briefly described in the "Elec. Eng.," May 29; it is said not to come within the scope of Berliner's claim, as it has no electrodes.

Mercadier and Anizan Microphone.—An illustrated description of this instrument is published in the "Elec. Eng.," May 29; the apparatus was described in the Digest, Feb. 2.

Telephone Situation.—"El'ty," June 5, publishes an article of some length on this subject, pointing out the growth of the independent companies, and discusses it editorially.

MISCELLANEOUS.

Gutta-percha.—The Lond. "Elec. Rev.," May 24, reprints a short article from the "Sarawak Gazette," regarding the project of Mr. Hourant. Two new enterprises have recently been started in the home of that journal, the collection and export of the dried leaves of the gutta-percha tree and the manufacture of cutch from the bark of a variety of the mangrove which is found in almost unlimited quantity in the swamps and on the coast; the former of these industries was commenced a year ago by Mr. Hourant; an excellent quality of pure gutta-percha is extracted from the leaves which are said to yield 7 to 10 per cent. of their weight or even more; the exporting is increasing month by month; the native plan of cutting down a tree to obtain the sap is wasteful in the extreme; an adult tree 25 or 30 years old yields only one catty of pure dry gutta-percha, while as much can be obtained from two pluckings of the leaves of a tree without injuring it, and it will long continue to put out fresh foliage; the gutta percha obtained from the leaves is chemically pure and dry; millions of the trees already destroyed by the old process are still of service as their stumps have sprouted, yielding leaves which are as good as those of an adult tree. (An article on this same process was abstracted in the Digest, March 25, 1893.)

Therapeutic Action of High Frequency Currents.—A translation of the short paper of Messrs. Apostoli and Berlioz, abstracted in the Digest, May 11, is published in the Lond. "Elec. Rev.," May 24.

Production of Phosphoretted Hydrogen and Calcic Phosphide.—According to an anonymous article in the "West. Elec.," June 8, it appears that calcic phosphide was produced by fusing bone charcoal with lime in an electric arc furnace; by immersing this compound in water, phosphoretted hydrogen is given out which explodes when it comes in contact with the air at the surface of the liquid.

Photographs of Lightning.—Several photographs taken recently in Texas are reproduced in the "Elec. Rev.," June 5.

Educational.—A paper from the "Technograph," by Messrs. Morrison and Junkersfield on "The College of Engineering," referring to the University of Illinois, is reprinted in abstract in the "West. Elec.," June 8.

New Journals.—A new journal called the "Electrical Journal" is to be published in Chicago every two weeks by Prof. Barlett; it appears from an advance circular to have some connection with the National School of Electricity; it is stated that it "shall also invade a new and unique field in this class of journalism," but what this field is is not described.

According to the "West. Elec.," June 1, a new electrical monthly called the "Electrical Journal" is about to be started in San Francisco; Mr. George P. Low is the editor and proprietor with Prof. Perrine as associate editor; it is to be an illustrated monthly review of the industrial applications of electricity, gas and power.

New Book.

Electric Motive Power: The Transmission and Distribution of Electrical Power by Continuous and Alternate Currents, with a Section on the Application of Electricity to Mining Work. By Albion T. Snell. London: "The Electrician" Printing & Publishing Company. 405 pages, 208 illustrations. Price, $4.00.

The preface states that this work is designed to be a practical treatise for mechanical and mining engineers and other students of applied electricity, and that an elementary knowledge of the theory of electricity and magnetism is taken for granted. In developing the principles governing electric transmission of power the author has deemed it advisable, in addition to treating the various systems in vogue of transmitting and distributing power, to discuss the design of continuous and alternating current dynamos and motors, and of transformers, and to pay especial attention to the subject of electricity in mining, particularly with reference to collieries and coal getting.

The first of the ten chapters deals with the general plan of electrical transmission of power; the functions of the dynamo, motor and line are rather unnecessarily described, but some useful practical information relating to them, as well as to the steam and gas engine and steam boilers, are given.

In Chapter III. the design of continuous-current dynamos and motors is very satisfactorily treated from a practical standpoint, and while the mention of some of the factors involved is rather brief, the information is always to the point, and the example given to illustrate the method of design will be found very instructive. The following chapter takes up the line, its material and insulation, and the theoretical considerations affecting the loss in the conductor being considered in the opening pages; line fittings, underground conduits and lightning protection devices complete the chapter. The portion on line drop is rather perfunctory, being largely a discussion of the considerations entering without any very definite conclusions, while considerably more space is given to lightning protection than to underground lines and conduits. It should be added, however, that the information here, as elsewhere throughout the book, is of a direct practical character and, therefore, of more value to the engineer than would be a more exhaustive treatment in the usual manner.

Chapter IV. treats of direct-current systems of transmitting and distributing power, including series and parallel working, three-wire and feeder systems, storage battery auxiliaries and dynamotors. Alternating currents are taken up in Chapter V. and the real value of the book lies in this and the following chapters on the same subject. The explanations of the various alternating-current phenomena are given in simple language and with reference to their practical bearing, no mathematics beyond a few formulas appearing in the text. Among the matters treated are the subject of harmonic functions, the cause and effect of phase differences, the effect of iron cores and, finally, a section giving brief allusions to the design of alternators, but which has some value in assisting to an understanding of the principles of the machines.

Chapter VI. is on transformers, from which an excellent idea of their principle construction and working may be obtained, the section on designing having here also an interest merely in that connection.

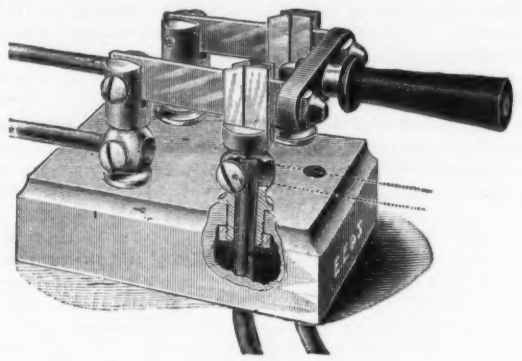
Chapter VII. takes up alternating-current transmission, and the sections on inductive drops on the line and the effect of capacity will give the reader a very good idea of these important points. Various methods of compensating for drop are described, and some points connected with alternating-current working, such as coupling in parallel, measuring instruments, earthing devices, etc., referred to; some remarks on precautions to be observed in alternating-current working will be found of practical interest.

Chapter VIII. is on polyphase-current working and contains more information on the practical side of the subject than can be found in any other work, the descriptions of the various systems being such as to be easily followed by the beginner. The two final chapters form a special treatise on the application of electricity to mining work, the information being given in much detail and apparently representing a considerable experience of the author in this branch of electrical engineering. As such it will be found of value to the mining engineer, the subject being treated from an engineering standpoint and much more fully than can be found in any other publication.

The chief value of the work lies in the practical light in which the various points treated are viewed, and in the discussion of their bearing on actual working. The author has apparently made a careful study of the recent literature relating to alternating currents and their working, particularly with respect to polyphased currents, and we believe that a more satisfactory practical idea may here be obtained in regard to these important subjects than in any other work yet published.

A "Baby" Knife Switch.

For some time the Electric Engineering & Supply Company, of Syracuse, N. Y., has been furnishing to the trade a neat and practical knife-blade switch, with a carrying capacity from 15 to 25 amperes, which is shown

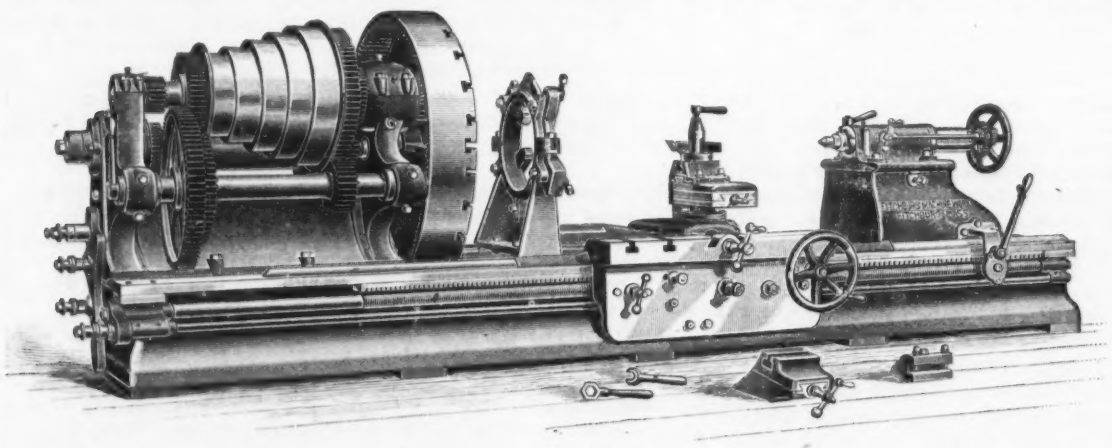


Small Knife-Blade Switch.

in the accompanying engraving. This switch is mounted on a porcelain base, fitted with combination terminals which will admit of either a face or a rear connection, the wires being held in either place by the same screw. The switch is small and compact, being only 2½ inches long by 1⅞ inches wide, and stands 1¾ inches high, base included. This little switch has become a great favorite in the construction of panel-board work, and has almost entirely supplanted snap switches. It is also furnished without the porcelain base, so that it can be mounted directly upon the switchboard.

A Large Engine Lathe.

The accompanying engraving illustrates the latest advance in heavy triple-geared engine lathe construction, made by the old established concern of the Fitchburg Machine Works, of Fitchburg, Mass. This concern has for over 31 years manufactured large numbers of lathes, planers, drills, shapers and other machine tools, which have ever been noted for the quality and quantity of work they would produce, and this lathe is no exception to the rule.



A 60-inch Engine Lathe.

The main spindle is relieved of all unnecessary weight by putting the cone and its back gears upon separate shafts, which goes far toward insuring permanent alignment of the spindle in its bearing. This is also made more certain by carefully and accurately prepared boxes of best bronze and best babbitt. This bearing has already produced good results, and is said to have shown absolutely no grooving in practice. The cone is well proportioned, as also are the back gears, giving uniform changes of speed. The lathe has a 60-inch swing and 18-foot bed. Gear feeds are used entirely, and by means of a clutch the deal screw is run only when used for cutting threads. By a simple device in the apron the lead screw nut cannot be locked and the feed rod thrown into gear at the same time.

The tailstock spindle is provided with an attachment so that it can be run from either end of the tailstock; the tailstock itself may be easily and quickly moved along the bed in either direction by means of a convenient lever. The lathe weighs 17 tons and the metal is most judiciously distributed, the tool being perfectly rigid and free from chattering or vibration.

Some Interesting Alternating-Current Installations.

An interesting power transmission plant is in course of installation at Bayonne, N. J., where the three-phase system of the General Electric Company will be employed to operate the machinery of the Tide Water Oil Company. The nature of the process is such that spark-proof apparatus is an imperative necessity, and multiphase apparatus was selected as being peculiarly adapted to meet the special conditions. The generator will be a 550-volt, three-phase machine, having eight poles and a capacity of 75 kilowatts. The several induction motors will be of 5, 10 and 15 horse-power. Some of these are spark proof, and have a permanent resistance in the armature circuit, as they will be employed in places where there exists an ever-present danger of explosion from gases, which a spark could readily ignite. They will be used to operate pumps, elevators, and other machinery. The switches will be of special construction, with the blades immersed in oil. The generator also supplies current for about 525 lights scattered throughout the different parts of the works. Regulation of the lighting circuits will be effected by special revolving regulators of novel design.

The Oakland Gas & Electric Company, of Oakland, Cal., will also use a three-phase transmission plant for general power work. Current to a number of induction motors ranging from one to fifteen horse-power will be supplied from a 75-kw, three-phase machine, and there will be extensive lighting in connection with the plant. The E. M. F. at the generator will be 2,000 volts, and this will be reduced at two centres of distribution to the necessary potential for the secondary network, which will cover a territory of 1,200 feet in every direction from both centres. From these points pressure wires will be run back to the power house, and the voltage will be there controlled by potential regulators.

A plan somewhat similar to this will be followed by the Fall River Electric Company, of Fall River, Mass., but monocyclic apparatus will be used instead of three-phase. Two 75-kw generators will be installed, and they will be used for lighting purposes during the dark hours, supplying current during the day for general power work. The motors will be of the General Electric induction type, ranging from 1 to 10 horse-power, and will be wound for 110 volts, to which pressure the current generated at 2,000 volts will be reduced.

The first application of the three-phase long-distance system to street railway work will be made by the General Electric Company at Lowell, Mass., where a plant is in course of construction for the Lowell & Suburban Street Railway Company. Its special features will render it one of the most interesting three-phase installations ever effected. The generators will deliver both alternating and continuous current, and when not in use for transmission work will be run in parallel with the railway generators now in the station. They will be wound for delivery of low voltage current at the alternating side, and this current, raised to 5,000 volts, will be carried to two sub-stations, one nine miles and the other 14 miles distant from the generating station. The sub-stations will each be provided with suitable step-down transformers of the General Electric air-blast type, and two rotary converters. These machines are constructed to maintain at the commutator brushes an E. M. F. of 500 volts at no load, and 550 volts full load. Another transformer sub-station for 400 incandescent lamps will be installed six miles from the generators.

The success of this plant will go far towards solving the problem of the operation of railways over long distances, taking the current from the one power station. When it is completed we shall present a full description to our readers.

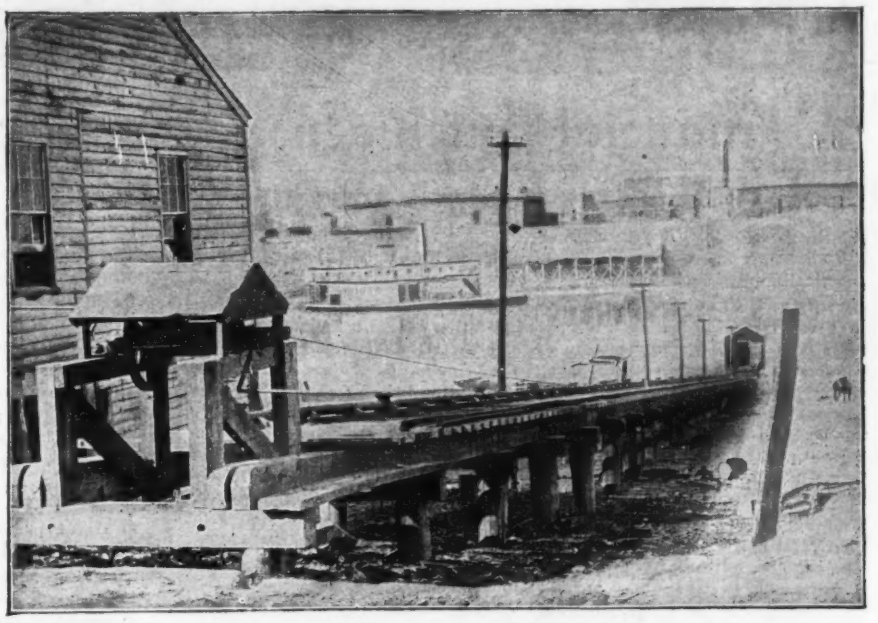


FIG. 1.—PUMP HOUSE AT EXTREME END OF RAILWAY.

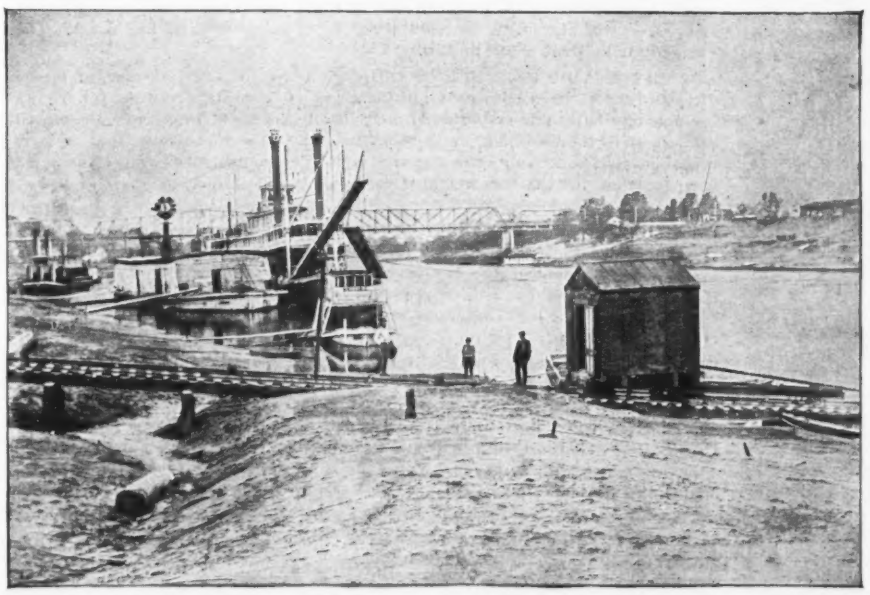


FIG. 2.—PUMP HOUSE HALF WAY UP RAILWAY.

An Electrical Pumping Plant.

A rather novel and quite unusual electrical pumping plant is shown in the accompanying illustrations of an equipment at Monroe, La., which was furnished by The Goulds Manufacturing Company, of Seneca Falls, N. Y.

The great variation in the height of the water in the river rendered it necessary to have a changeable location for the pumps in order that the suction pipe should be always sufficiently submerged. With this end in view a railway was built so as to extend well into the river at low water. Upon this railway, mounted on a four-wheeled truck, a pump house was constructed, in which is an 8 by 10 foot Gould triplex power pump driven by a 15-hp slow speed Westinghouse electric motor. When rendered necessary by the rise and fall of the water, the position of the pump house on the railway is changed by means of the windlass shown at the head of the railway in Fig. 1. This view shows the pump house at the lower end of the railway, the water being low. Fig. 2 shows the pump about half way up the incline, with the discharge pipe extending from the rear of the pump house into the water.

Owing to the variation in the location of the pump house, special provision had to be made for connecting the pump with the discharge pipe, and this has been accomplished, as may be seen from Fig. 1, by extending the main the entire length of the railway, and putting flanged tees at regular intervals, connection between the pumps and main being established through the nearest tee. In order to supply the necessary current for operating the motor, a line of poles was erected alongside the railway to carry the wires which lead current to the motors

This electrical pumping installation is the property of the Monroe Water & Light Company, from whose central station the current for the motors is obtained. In spite of the conditions under which the pump is operated and the frequent changes of the pump house, the performance of the outfit has been eminently satisfactory from the start.

The Snaefell Mountain Railway.

Work on the electric railway to the summit of Snaefell Mountain, Wales, is progressing rapidly, and the road is expected to be ready for July. The overhead system will be used, and when this line is completed there will be a complete stretch from Douglas to Laxey, and thence to Snaefell, about ten miles in all.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, June 8, 1895.

AMERICAN BELL has apparently reached its upward limit, having remained practically unchanged for two weeks.

GENERAL ELECTRIC was rather strong this week, and its friends claim that the firmness of the stock is a sure indication of some practicable plan to put electrical manufacturing upon a firmer basis than heretofore, though the connection seems rather vague. One of the principal General Electric bears has recently climbed the fence and expresses the belief that Mr. Pierrepont Morgan contemplates the organization of a gigantic corporation to absorb both the General Electric and the Westinghouse companies. Another rumor is current to the effect that the element in the General Electric board which was formerly opposed to the Westinghouse alliance is now in favor of it. It is safe to say that these reports have much to do with the bullish feeling as to G. E. stock, though their authenticity does not follow.

BALTIMORE TRACTION was bid up over 19 early in the week and continued strong. The advance has given rise to the report that insiders are buying the stock in order to put it above 25 and enable the company to issue the balance of the authorized stock—$4,250,000—which cannot be sold below par. Philadelphia directors of the company say that the matter has not even been considered, as the money is not needed. Last month the earnings increased about $400 per day; the increase during the first three days of June was $4,500!

	Par.	Bid.	Asked.
ELECTRICAL STOCKS.			
Chicago Edison Company	100	120	125
Edison Electric Ill., New York	100	99	101
" " " Brooklyn	100	..	108
" " " Boston	100	129	130
" " " Philadelphia	100	..	115
Edison Ore Milling	100	13	15
Electric Storage Co., Philadelphia	100	..	26½
General Electric	100	36½	36¾
General Electric, pref	100	..	65
Westinghouse Consolidated, com.	50	33	33⅛
" " pref	50	52	52⅛
BONDS.			
Edison Electric Ill., New York	100	105½	105⅝
Edison Electric Light of Europe	100	75	85
General Electric Co. deb. 5s	100	..	90¼
TELEGRAPH AND TELEPHONE.			
American Bell Telephone	100	202	203
American District Telegraph	100	30	40
American Telegraph & Cable	100	94½	..
Central & South American Telegraph	100	117	120
Commercial Cables	100	150	..
†Erie Telephone	100	57¼	57¾
Gold & Stock Telegraph	100	105	..
New England Telephone	100	73	73½
New York & New Jersey Telephone	100	103	105
Postal Telegraph-Cable	100	63½	..
Western Union Telegraph	100	92	92⅛
ELECTRIC TRACTION STOCKS.			
Baltimore Traction	25	19¾	20
Binghamton RR. com	100	100	..
Brooklyn Traction	100	11½	14
" " pref.	100	..	53
Buffalo St. Ry	100	79	83
Cleveland City Ry	100	68	70
Cleveland Electric Ry	100	59	60
Chicago City Ry	100	305	315
Columbus St. Ry	100	48½	..
Consolidated Traction of N. J	..	26	30
Electric Traction, Philadelphia	50	..	74½
Hestonville	100	60	..
Long Island Traction	100	11	11⅛
Louisville St. Ry. com.	100	37	39
" " " pref.	100	87	88
New Orleans Traction	100	20	22½
" " pref.	100	69	71½
North Shore Traction	100	23	28
" " pref.	100	78	81
People's Traction $30 pd	25	62¼	62⅛
‡Philadelphia Traction	50	83⅛	83½
Rochester St. Ry	..	38	..
Union Ry. (Huckleberry)	100	112	115
West End, Boston	100	70	70½
" " pref	100	..	92
Worcester Traction	100	13	16
" " pref	100	83	87
BONDS.			
Buffalo St. Ry. 1st con. 5s	100	104	106
*Binghamton Railroad Co. 5s	100	99	100
*Columbus St. Ry. 1st 5s	100	98	..
Rochester St. Ry. 1st. 5s	100	95	97
*Union Ry. 1st. mtge 6s	100	105	108
*Westchester Electric 1st. mtge. 5s	100	98	101

* With accrued interest.

† Ex-Div.

‡ Ex-rights.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
253 BROADWAY, NEW YORK, June 10, 1895.

THE TROLLEY SYSTEM WAS INAUGURATED last week on all the lines in Elizabeth, N. J., which are controlled by the Consolidated Traction Company.

MR. JOHN STARR, of the electrical supply firm of John Starr, Son & Co., Ltd., Halifax, N. S., was in the city last week. Mr. Starr reports a very decided improvement in electrical trade in Canada.

THE ELECTRICAL CONTRACTORS' ASSOCIATION has been organized in Brooklyn. Peter D. Myers is president, Wm. H. Dean, vice-president, Wm. H. Pearson, secretary, and Geo. J. Soper, treasurer.

NO SUBSIDY.—The Staten Island supervisors have adopted an opinion from George M. Pinney, Jr., to the effect that it is not within their power to offer a $1,000,000 subsidy to the General Electric Company as an inducement to concentrate its various factories at Staten Island.

THE BOARD OF ELECTRICAL CONTROL last week, at a special meeting unanimously voted to grant the request of the Union Railway Company for permission to string trolley wires the entire length of the Southern Boulevard in the annexed district, a distance of three and one half miles.

ELECTRICAL WORKERS are getting restive again, this time over Clause 2 of the agreement made by the arbitrators of the recent strike, under which clause the Electrical Contractors Association claims the right to keep non-union men at work, while a majority of Electrical Workers No. 3 argue otherwise.

CONSIDERABLE ANNOYANCE was experienced yesterday by the Union Electric Railway, which runs through Westchester towns to 129th Street, New York. Passengers from Westchester and Wakefield insisted on paying only one fare to 129th Street, in compliance with the law recently passed prohibiting a charge by railways of more than one fare within the city limits, which now enclose the towns above named.

FOUND GUILTY.—Judge Kirkpatrick has decided that the indictment is legal which was returned some time ago against the Consolidated Traction Company for maintaining a nuisance by laying a third rail on Market Street, Newark, in changing the gauge of the roadbed. As the company had admitted the presence of the rail he ordered a verdict of guilty entered against it. The company is liable to a fine of $500.

THERE IS A DIFFERENCE OF OPINION between Mayor Wanser, of Jersey City, and the Western Electric Light Company, concerning a contract for wiring the new city hall. The mayor and the City Hall Commission desire iron-armored conduit to be used without extra compensation to the contractors, but there is no provision for the tubing in the contract. The contractors argued for extra compensation, but the mayor said "No," and said it emphatically.

RECEIVER APPOINTED.—The Electrical & Mechanical Engineering Company, of No. 41 Cortlandt Street, has become insolvent, and Judge Andrews has appointed Jonathan H. Vail receiver, on the application of the directors. Mr. Vail is president of the company and the largest stockholder. The liabilities are $76 441 and the principal asset is a contract with the Brooklyn Bridge trustees for electric lighting of the cars. This asset is set down as $19,419.

EXTENSIVE TROLLEY CAR FACILITIES.—The New Jersey Electric Railway Company has arranged with the North Hudson County Company for a system of transfers by which passengers from the former may be transferred, without extra charge, to practically any part of Hudson County, including all the New York ferries from Pavonia to Weehawken (Forty-second Street), the Hudson County Court House, Union Hill and other points. It is confidently expected that the company will, in a few weeks, be running its own lines through Hoboken to the various ferries.

LIVELY COMPETITION FOR BROOKLYN'S LIGHTING.—Bids were opened last week from the Municipal, Citizens' and Edison illuminating companies for furnishing Brooklyn with electric lights. All the bids offer 1,200 cp lamps at 40 cents per night from Jan. 1, 1895, until the new contract is made, and 35 cents during the remainder of the year provided they can put in 20 per cent. more lights. The Edison Company also put in a bid of 20 cents per night for 600-cp lamps. City Commissioner White expresses himself as very well satisfied with the results of the bidding. The reduction of five cents per lamp per night will effect a saving to Brooklyn of $42,000 a year. This year's appropriation will allow the 20 per cent. increase stipulated by the bidders.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
ROOM 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., June 8, 1895.

ELECTRIC METERS IN MASSACHUSETTS.—The gas commissioners' report on meters, presented to the senate last week, states that about 15,500 meters were in use during 1894.

THE WEST END STREET RAILWAY COMPANY, Boston, has issued its order concerning the carrying of mail pouches on cars other than those fully equipped as United States mail cars, and the employees regard the movement as a cunning scheme to avert a tie-up on the road.

THE MASSACHUSETTS LEGISLATURE has finally adjourned and it may be said to its credit that it passed no legislation materially affecting electrical interests. The subway of Boston will now proceed toward construction without interruption. The legislative attempts to obstruct the work were a failure and now Judge Knowlton, of the Supreme Court, has denied the application for an injunction.

THE PITCHBURG MACHINE WORKS have nearing completion in their shops in Fitchburg, Mass., a massive iron planer, to plane 73 inches x 73 inches x 26 feet long, with two cross and two side heads, all from 1895 patterns. This well-known company reports an increased demand for its tools. The Stanley Electric Manufacturing Company, of Pittsfield, Mass., is one of its larger patrons and strongly endorses its tools.

THE NARRAGANSETT MACHINE COMPANY, of Providence, R. I., reports increased demands just now for its well-known Providence foot lathe, one of its standard manufactures and which has been before the public for a number of years, always receiving liberal recognition. For electrical and experimental work and for all classes of mechanics, practical and amateur, this lathe is regarded as possessing excellent features and merit.

ELECTRIC LINE BETWEEN HINGHAM AND NANTASKET.—At a meeting of the stockholders of the Hingham Street Railway Company, held this week, it was voted to sell the franchise for a railway to connect with the Nantasket Beach branch to the Braintree & Weymouth Street Railway Company. The terms are $5,000 bonus and reimbursement for expenses already incurred by the Hingham Company. It is intended to have the road in operation by July 10.

THE BUCKEYE ENGINE COMPANY continues to make an excellent showing of business in the New England territory through the energetic efforts of its New England agent, Mr. W. D. Hoffman, whose offices are at 620 Atlantic Avenue, Boston. Mr. Hoffman's business for April was very gratifying and has been particularly so during the ten days commencing with the latter part of May and entering into June, during which time he disposed of five engines. The business, by the way, of the Buckeye Engine Company was exceedingly good during the month of May, orders for 34 engines being booked, aggregating 4,484 hp.

THE SESSIONS FOUNDRY COMPANY, Bristol, Conn., has in course of construction on a large tract of land adjoining the railroad in a different part of the town, its immense new iron foundry plant, and hopes to have it ready for occupancy early in October. Meanwhile the business is being conducted as usual at the old works. When finished the new plant will be one of the most complete establishments of its kind to be found anywhere and will possess unsurpassed facilities for producing iron castings of the best quality and in large quantities. The main foundry building will be 530 feet long and 110 feet wide. There will also be large shipping buildings, power house, electric power and lighting plant, machine and pattern work shops, pattern storage, office building, etc, all of which will be practically fireproof. There will be several spur tracks running into the yard, affording excellent facilities for receiving and shipping freight. The Sessions Foundry Company has always enjoyed liberal patronage from the electrical industry because of the excellency of its manufactures, and which will undoubtedly be increased to a large degree upon the completion of its new plant.

CANADIAN NOTES.

TORONTO, Can., June 8, 1895.

HAMILTON, ONT.—Tenders for lighting the city will be asked for at once by the City Council.

MR. R. E. T. PRINGLE has been given the sole agency in Canada for the Boudreaux Dynamo Brush.

MUNICIPAL OWNERSHIP WAS REJECTED by the taxpayers in Toronto a few days ago by an overwhelming majority, the vote being 4,510 to 817.

COLLINGSWOOD, ONT.—Tenders are wanted, in whole or in part, for the steam plant, electrical plant and electrical supplies necessary for the extension of the electric light system of the town of Collingswood, Ont., and will be received until June 19, by C. James Guilfoyle, chairman of the water works committee.

General News.

TELEGRAPH AND TELEPHONE.

KINGSTON, N. Y.—The West Shore Telephone Company is about to extend its lines to Ellenville.

QUINCY, FLA.—The Florida Telephone & Construction Company will equip an exchange in Quincy.

TOMAHAWK, WIS.—The Standard Telephone Company has most of the poles set for its new line here.

DULUTH, MINN.—An ordinance granting a franchise to the Duluth Telephone Company to place its wires in a conduit is before the Council.

GAINESVILLE, GA.—A local telephone exchange will be established with probability of an extension to Jefferson. G. G. Leake can furnish information.

VICKSBURG, MISS.—Proposals for the construction of an automatic fire alarm telegraph system will be received until June 17. W. L. Trowbridge is mayor.

BOWLING GREEN, KY.—The East Tennessee Telephone Company is extending its line to Hays and the telephone line from Brownsville to Rocky Hill station is being extended on to Hays and Smith's Grove.

BURLINGTON, IA.—The Burlington Electric Light & Street Railway Company, E. C. Walsh, president, is receiving bids for telephone instruments for the new exchange and for the long line to Columbus Junction.

BALTIMORE, MD.—Sealed proposals will be received by the construction committee of the underground system of the police and fire alarm telegraph and police patrol until 12 m., June 20, for the construction of about 45,000 feet of electrical subway conduits, in accordance with drawings, etc., prepared by the engineer.

ELECTRIC LIGHT AND POWER.

CANTON ILL.—J. Krishke is inviting bids for furnishing the city with electric arc lights.

PUEBLO, COL.—Judge Halleck has ordered the Pueblo City Railway sold to satisfy a $500,000 mortgage.

ALBANY, N. Y.—The bill appropriating $16,000 for an electric light plant for the Albany Armory has become a law.

FRANKLIN FALLS, N. Y.—The Franklin Falls Company will erect a new power house on the island in the river.

KANSAS CITY, MO.—The Kansas City & Independent Air Line Railway will probably build an electric power plant.

BALTIMORE, MD.—The plant of the defunct Baxter Electric Motor Company was sold recently to bondholders for $25,000.

ATHENS, GA.—The Athens Electrical Railway Company is in the market for electrical equipment for light or power lines.

NEW ORLEANS, LA.—The Orleans Railway Company will erect a brick power house and power building to cost $13,975.

BRISTOL, CONN.—The Consolidated Electric Company will build a power house to be equipped with engines, dynamos, etc.

WELLSVILLE, O.—E. H. Wells & Co. are arranging to put in position a new electric light plant in the basement of their building.

SCOTTSDALE, PA.—E. L. Rutherford is inviting bids for furnishing electric lights for streets and public buildings for Brooklyn for 1895.

LEXINGTON, KY.—The mayor can give information concerning an electric light plant now being considered and for which bids are being invited.

WOONSOCKET, R. I.—The machinery in a shoe factory to be erected on Brooke Street by Assemblyman Dulude will be operated by electric power.

PENSACOLA, FLA.—The Pensacola Electric Light & Power Company is arranging to run motors during the day for propelling fans and light machinery in the city.

NORWALK, O.—The Norwalk City Council has passed resolutions submitting the proposition to a vote of the people for $25,000, to construct its own electric light plant.

WORTHINGTON, MINN.—The Village Council of Worthington has called a special election for June 15, to vote on the question of putting in a $15,000 electric light plant.

KOSSE, TEX.—Fletcher Allen is in the market for a complete electric light plant, including a 50-hp engine, 60-hp boiler, 500-light dynamo, 3,000 pounds of wire, 250 lamps, with sockets, insulators, brackets and arms.

LAUREL, MD.—The Laurel Electric Light plant has been purchased by a local company of which Dr. De W. Snowden is president, and has been reorganized under the name of the Electric Company of Prince George's County.

ANNAPOLIS, MD.—An ordinance has been passed authorizing the Chesapeake & Potomac Telephone Company, of Baltimore, to erect and maintain poles and string wires on the streets of Annapolis, for a period of 10 years.

HELENA, MONT.—The City Council has awarded W. J. Bradshaw the contract for lighting the streets. The contract is for three years from July 1. Equipment for 75 arc lights and a medium size incandescent plant will be purchased at once.

MERRIMAC HIGHLANDS, MO.—The Merrimac Highlands Company has purchased the franchise of the Sunset Hill Water, Light & Power Company, and will construct works to supply a number of towns in St. Louis County. The president is Marcus Bernheimer.

BALTIMORE, MD.—Arrangements have been completed for building the Washington & Baltimore electric road, between the two cities. A director of the company says that the Widener Elkins street railway syndicate of Philadelphia has become interested in the new line.

BELLEFONTAINE, O.—Bids will be received until June 25, by the mayor for an electric light plant comprising two 50-light arc dynamos, one 650-light alternator, with lamps, converters, pole line, wiring and steam plant complete. Specifications are on file at the office of the engineers, E. P. Roberts & Co., Cuyahoga Building, Cleveland.

DAVENPORT, IA.—The business of the Davenport Power & Light Company, of Davenport, Ia, has been rapidly growing under the successful management of William Mullen. When he took charge of the property the company's business was small and unsatisfactory, but since that time it has become necessary to install a 500-hp engine, and the capacity of the plant is soon to be doubled. The increase in business was secured at the same time in the face of very active competition from other illuminating companies.

THE ELECTRIC RAILWAY.

PORTLAND, ME.—The Portland Street Railway will be operated by electric power.

TORRINGTON, CONN.—The Derby Street Electric Railway will be extended to Seymour.

NORRISTOWN, PA.—The Schuylkill Valley Traction Company will extend the road to Collegeville.

ANNISTON, ALA.—The Anniston City Railway Company has decided to change its line to the trolley system.

CONCORD, N. H.—It is proposed to extend the Concord & Penacook Electric Road to the Hannah Dustin monument.

LITTLE ROCK, ARK.—J. H. Healy and others have asked for a franchise to build an electric line along several streets of the city.

MILFORD, MASS.—At a special town meeting $2,000 was subscribed upon condition that the proposed electric road be constructed.

CHESTER, PA.—The preliminary surveys are completed for the Prospect Park Street Railway, and work will soon be commenced.

ASHLAND, MO.—An electric railway from Ashland to Mexico and passing through Englewood is reported to be under consideration.

CLARKSVILLE, TENN.—The Clarksville City Railway Company is in the market for electrical car equipments. Wm. Daniels is president.

ST. LOUIS, MO.—The People's Railway Company, Charles Green, president, is about considering the plan of an underground electric conduit road.

FORT MADISON, IA.—J. C. Hubinger has petitioned the Council for a franchise to operate an electric street railway on certain streets of the city.

GREENVILLE, S. C.—W. A. Hudson and J. C. Smith, with Atlanta parties, are endeavoring to secure a franchise to build an electric road in Greenville.

NIAGARA FALLS, N. Y.—The Buffalo & Lewiston Electric Railway Company has a petition before the Council asking for a franchise in Third Street.

ELIZABETH, N. J.—The Elizabeth Street Railway Company will extend its tracks up Morris Avenue to the city line. Electricity will be used as the motive power.

NEW ORLEANS, LA.—The Canal & Claiborne Street Railway Company is preparing plans to change its line into an electric system. There are 13 miles of road.

SOMERVILLE, MASS.—The Somerville car line will use electricity for its motive power and a new carhouse is to be erected near the terminus in West Somerville.

PRINCESS ANNE, MD.—An electric line will probably be built from Princess Anne to Deal's Island. The distance is about 10 miles. T. Bock and others are interested.

SAN FRANCISCO, CAL.—The Market Street Railway Company is about to expend $100,000 in the improvement and extension of the Ellis and O'Farrell Street lines.

BOWLING GREEN, KY.—The Park City Railway Company will erect a power plant to contain 150-hp generators and to operate eight to ten miles of railway, etc.

FORT WAYNE, IND.—A. B. White, of Fort Wayne, is interested in the project of building an electric railway in Fort Wayne and in the town of New Haven, six miles distant.

NEW HAVEN, CONN.—The managers of the Centreville Electric Road are making arrangements for the extension of the line from its present terminus out to Centreville.

WILLIAMSTOWN, PA.—The City Council has passed an ordinance granting ight of way to the Williams Valley Electric Railway Company, over the veto of Chief Burgess Lebo.

HYDE PARK, MASS.—The Selectmen have received a petition from the Norfolk Suburban Street Railway Company for permission to extend its tracks on Hyde Park Avenue.

PAINESVILLE, O.—The Cleveland & Painesville Railway Company has been granted a franchise for an electric railway along the public highway from the west line of Lake County to Painesville.

FORT LEE, N. J.—The Bergen County Traction Company has filed with the township authorities the consents of the propery owners along the route of the proposed extension of the company's lines.

TROY, N. Y.—Steps are being taken to extend the electric line from Albia, the terminus of the Troy City Railway, to West Sand Lake. The estimated cost is $150,000, which amount has been partly subscribed.

RAHWAY, N. J.—J. H. Zingley has secured the right of way from the property owners for an electric railway from the Tottenville Ferry landing at Perth Amboy to Smith's factory, and work will begin at once.

VICKSBURG, MISS.—All difficulties in the way of building an electric line here have been removed by a recent Supreme Court decision, and the citizens are anxious for a road, as well as an electric light plant.

Personal Notes.

DR. FREDERICK BEDELL, of Cornell University, will sail for Europe on June 19 for a summer on the Continent, and in the fall will attend the meeting of the British Association at Ipswich.

MR. ARNOLD SPILLER, who has been associated with the Buckeye Electric Company, of Cleveland, O., for the last four years, has resigned his position as expert and factory superintendent. He will, after a brief holiday at his home in London, England, make an extended visit to the continent of Europe to take up several matters relating to that branch of electrical manufacture in which he has so successfully been engaged in this country.

Trade and Industrial Notes.

MR. W. J. NEWTON wishes to announce to his friends in the trade that he has severed all connections with the Newton Electric Company and has established the W. J. Newton Company, at 39 and 41 Cortlandt Street, New York, where he is prepared to take orders for his well-known specialties.

AN ALL IRON CAR BARN, 40 x 160 feet, is to be built by the Berlin Iron Bridge Company, of East Berlin, Conn., for the Norwalk Tramway Company, of Norwalk, Conn. The Berlin Company has also been awarded the contract for the various extensions of the Central Railway & Electric Company, of New Britain, Conn.

A PROFITABLE TRIP through the South has just been completed by W. C. McKinlock, the genial secretary of the Metropolitan Electric Company, of Chicago. He secured some nice orders, and reports a decided improvement in business. The Metropolitan Company has secured an order for its portable fire hose bridge from the Chicago Transit Company.

J. A. MACHADO, electrical machinery, 203 Broadway, New York, has become the New York manager of the Louisville Electrical Works Louisville, Ky., and has added their excellent and very complete line of transformers to the other well-known standard goods handled by him. Mr. Machado reports increasing inquiries and sales for Triumph motors, Hill switches, Whitney instruments and other specialties.

GRATIFYING RESULTS are reported by the Electrical Appliance Company of Chicago, as having been secured from numerous tests of Packard lamps made independently by lamp users themselves in different parts of the country. In several cases, it is claimed, it was demonstrated that the Packard lamp would only have to burn a few hundred hours to make its increased efficiency over the other lamps tested pay for the entire first cost of the lamp.

THE NEW KNOEDLER ART GALLERIES, at 355 Fifth Avenue, New York, have been most satisfactorily fitted up throughout with the latest improved reflectors, made by I. P. Frink, 551 Pearl Street, New York. The same firm is now fitting up the Carnegie Library and Art Gallery in Pittsburgh, Pa., putting in their system in three large galleries on each of two floors, and also in the residence of Mr. Joseph Jefferson, Buzzard's Bay, Mass.

STREET LIGHTING.—Nations may be ungrateful, but the chief officials in our western cities are not so constituted, judging from a letter recently received by the Standard Electric Company, of Chicago, from which the following is an extract: "The Standard arc dynamo we bought of you has been in constant use in all-night service, since November, 1893, and has not cost one cent for repairs. I find it more economical to operate—in the amount of power required—than any other dynamo we use."

A NEW ATTACHMENT PLUG AND RECEPTACLE are being put on the market by Wm. T. Pringle & Co., 1028 Filbert Street, Philadelphia, into which they have introduced several features of merit and novelty. This firm's success with switches, switchboards and electric light fittings is largely due to the fact that they do not accept the common opinion that such standard device, are not amendable to further notable improvement, but, on the contrary, find constant occasion for changes in the direction of greater efficiency.

CONGRATULATIONS WERE EXCHANGED BY TELEPHONE between the municipal authorities of Paris, Sherman, Dallas, Fort Worth, Waco and Austin, Tex., upon the recent occasion of the opening of the Erie Telephone Company's long-distance system in Texas, and the lines worked perfectly, the longest distance talked over being from Paris to Austin, which is 350 miles. The Erie Company expects to complete its Austin-Galveston long-distance circuit by July 1. This will make the longest circuit in Texas, from Paris to Galveston, 510 miles.

NEW QUARTERS have been secured by the Chicago branch of the Prentiss Tool & Supply Company, of 115 Liberty Street, New York City, at 62 and 64 South Canal Street. The new quarters are finely located, and equipped with every essential for the convenient and efficient handling of the large business done by the Prentiss Company at this point. The show room and offices occupy a floor space of 40 x 140 feet, and a complete line of new and second-hand machinery of the latest and most improved design will be carried at all times.

THE WHITNEY ELECTRICAL INSTRUMENT COMPANY, of Penacook, N. H., has opened an office at Buffalo, N. Y., in the Erie County Bank Building, where will be carried at all times a large stock of its standard instruments so that the trade in that locality may be promptly suppled. Mr. Frank C. Perkins is in charge of the office as selling agent, and a better selection could not possibly have been made, as Mr. Perkins is as well and favorably known to the trade as are the excellent instruments manufactured by the Whitney Company.

A TREATISE ON THE STEAM SEPARATOR is being distributed free by C. D. Mosher, No. 1 Broadway, New York. The book discusses the object, principle of action, and practical application of the separator, and also contains an abstract of Mr. Kerr's Franklin Institute paper on "The Steam Loop." Concise illustrated descriptions are given of the Mosher separators for steam and oil, with full directions for installation and care and a table of dimensions. Though primarily a trade catalogue, the pamphlet is thoroughly interesting and instructive.

STREET LIGHTING RATES.—Many municipalities have determined to pay a lower rate for street lighting during the coming fiscal year, and where the local lighting company has refused to accept the lessened price, the question of municipal ownership is being agitated. Naturally the central station manager is in a quandary. How best can this problem be solved is the question of the hour. The Standard Electric Company, of Chicago, believes that the solution offered by its Mr. F. E. Drake is worthy of careful consideration, as he claims to effect a very material saving in the operating expenses of arc lighting stations.

THE COST OF OPERATION is one of the most important points discussed by the Sulzer-Vogt Machine Company, of Louisville, Ky., in its new catalogue of electric elevator equipments. Other interesting features of the pamphlet are comparisons between electricity and steam, and electricity and water for elevator operation; a list of advantages embodied in electric elevator mechanism, and descriptions of the controlling and safety devices used by the Sulzer-Vogt Company. The pamphlet here mentioned is a supplement to the company's general catalogue of elevators and elevator machinery, every description of which it manufactures.

PURE DRAWN COPPER is the material which the General Incandescent Arc Light Company, 572 First Avenue, New York, claims to use in its knife blade switches. A catalogue of these switches has recently been issued in which attention is called to this point, and which contains descriptions and prices of every kind of blade switch known to the trade, including special high voltage switches and an electric clock switch designed to turn off the current at any predetermined hour of the day or night. This switch is in extensive use on the circuits of the Edison Illuminating Company, of Brooklyn, and is reported as giving entirely satisfactory service.

STEAM HEATING by the Williames vacuum system is the subject treated in a 55-page catalogue issued by Warren Webster & Co., Inc., of Camden, N. J. In addition to a full explanation of the system, well-illustrated, and some forcible

arguments concerning the economy obtainable by the use of it, there are copious testimonials from users, who are practically unanimous in declaring the Williames system entirely satisfactory and capable of fulfilling all the claims made for it by the manufacturers. An interesting detailed statement is presented from Mr. Albert J. Farrell, of the Chicago & Northwestern Railway Company, regarding a large plant in use at the Chicago station of that company.

CHLORIDE SURGICAL BATTERIES.—James G. Biddle, Drexel Building, Philadelphia, as special agent of the Electric Storage Battery Company, has recently brought out a complete line of "Chloride" surgical batteries which promise to meet the requirements of the medical profession in a most satisfactory manner. The lead plates are contained in sealed hard rubber cells, which in turn are handsomely mounted in mahogany cases with rheostats, pilot lamps, commutators, etc. Mr. Biddle is arranging with prominent houses throughout the country to handle these outfits, so that physicians, hospitals and medical colleges can obtain them through local dealers in any large city.

RAW SILK MACHINERY WIPERS.—The American Silk Manufacturing Company, of Philadelphia, the original manufacturer of the genuine raw silk waste machinery wiper in this country, has recently acquired the trade of the Royal Silk Manufacturing Company, of New York, the latter company having gone out of business. It is claimed by the American Silk Manufacturing Company, and freely testified to by users from all parts of the Union, that these original wipers, in connection with their improved special washing compound, furnished free, save over 100 per cent., as compared with cotton waste, in any large steam plant or mill, besides affording immunity from fire due to spontaneous combustion.

STEAM ECONOMY is the object of an adjunct for central stations and power stations which the Holley Steam Engineering Company, 344 Butler Exchange, Providence, Mass., is now manufacturing, and which it has lately applied in the power house of the Broadway Cable road, of New York, and the tunnel power house of the Baltimore & Ohio Railway Company, Baltimore. The Holly gravity return, as it is known, is a system for returning condensation water from engines and piping of steam plants to the boiler without pumps, traps or similar devices. The apparatus employed for this purpose is vastly more simple and reliable than the devices it replaces, and enables a notable saving in coal to be made.

INCREASING NUMBERS.—The Ball Engine Company, of Erie, Pa., continues to add to the number of its patrons. Ball engines, direct-connected to "C. & C." dynamos, will be used in the new National Bank of Commerce Building, Pittsburg, and the Tradesmen's Bank Building will have an electric light plant driven by three Ball engines. A 225-hp engine has been sold to the Edison Light & Power Company, La Crosse, Wis., to drive two General Electric dynamos, direct-connected, one on each side of the engine. The Mount Washington Light & Power Company, Hollins, Md.; the Juvenile Offenders' Home, Geneva, Ill., and the Catholic University, at Washington, D. C., are among recent purchasers of Ball engines.

INTERESTING INFORMATION is contained in a pamphlet just published by the Electric Storage Battery Company, of Philadelphia, in which the use of accumulators for telegraph work is exhaustively treated. "Chloride" accumulators, of course, form the "burden of the song," and the fact that these have been adopted by the Western Union, Postal Telegraph, American Bell Telephone and Gold & Stock companies would seem to furnish ample justification for the claim that they leave practically nothing in reason to be desired. The pamphlet contains diagrammatic illustrations of storage battery installations in several large telegraph offices, including the Western Union office at Atlanta and the Postal office at Baltimore. Particular attention is called to the great convenience and cleanliness of accumulators as compared—or contrasted—with the sulphate of copper batteries so generally used heretofore. Although the pamphlet has been out only a week, the company has received a great many inquiries regarding storage batteries for telegraphic and kindred work.

A NEW ENGINEERING ENTERPRISE. Messrs. Shepard & Searing, mechanical and electrical engineers, of Denver, Col., in conjunction with Mr. William T. Miller, formerly owner of the Miller Forge Company, of Pittsburg, Pa., have purchased the machine shops and foundry of the Overland Machinery Company, of Denver, and have incorporated the Denver Engineering Works Company to manufacture mining, milling and smelting machinery, and take contracts to design and erect complete mining, steam and electric plants. Especial attention will be given to the electrical transmission of power as applied to mines and smelters, in which they have had considerable experience. The officers of the company are: President, William T. Miller; vice-president, Frank E. Shepard; secretary and treasurer, Lewis Searing. The Board of Directors contains some of the best men of Denver: Henry R. Wolcott, president of the Denver Equitable Company; Julian A. Kebler, general manager of the Colorado Fuel & Iron Company; John L. Jerome, treasurer of the Overland Cotton Mills, and H. H. Dunham, of Wolcott & Vaile.

THE CRY MADE AGAINST OVERHEAD WIRES has caused a considerable increase in the demand for underground conduits, and, as a consequence of this demand, the Michigan Pipe Company, of Bay City, Mich., a large manufacturer of wooden pipe, situated near the finest forests east of the Rocky Mountains, has recently put in special machinery and a modern creosoting plant for making and treating underground conduits. It has been found necessary to have the holes in the conduit smooth and straight, without "shoulders" in the holes or "lips" at the joints, and to have as few joints as possible. It is also desirable to have the materials from which the conduits are made softer than the lead coverings of the cables so as not to scratch them or offer resistance in pulling them through from manhole to manhole. Wooden conduits fill all these requirements, and when treated with dead oil of coal tar will last for years. The superior qualities of creosoted wooden conduits have been recognized from the first in Philadelphia, where 625 miles of buried wires have been said in them, and in Brooklyn where the New York and New Jersey Telephone Company has 150 miles of it. In Boston large quantities have been laid, and a great deal is being laid there at the present time. The Michigan Pipe Company is now turning out large quantities of creosoted conduit for eastern points.

Business Notices.

ELECTRIC LEAGUE.—Meets every Thursday evening, 100 West 24th Street. Electrical engineers and electricians cordially invited.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren Street, Syracuse, N. Y.

NOTICE IS HERBY GIVEN that I have no connection with the old Newton Electric Company and am not in any way responsible for debts contracted by them since April 11 last. W. J. NEWTON, 39 Cortlandt Street, New York.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED JUNE 4, 1895.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

REISSUE of 527,958. 11,498. ELECTRICAL SIGNALLING SYSTEM; B. A. Fiske, United States Navy. App. filed Feb. 16, 1895. The combination of a source of electricity, two bodies of conducting material, two contacts moving thereon, an electrical indicating instrument, the said elements being connected in a Wheatstone bridge circuit, the said circuit being constructed so that when the two contact arms on the conductors press at points similarly marked at the two stations, the bridge is not in equilibrium, and the indicating instrument is normally deflected, so that any disarrangement of the circuit will cause it to fly back to a neutral position and thus indicate the defect.

540,239. TELEPHONE SYSTEM; W. W. Dean, St. Louis, Mo. App. filed Feb. 21, 1895. The combination of a number of lines extending to a central station, a battery at the said central station connected with all of said lines, a retardation coil included in circuit between each line, a storage battery in the line circuit at each sub-station and adapted to be traversed by current from the said battery, and switch contacts controlled by the removal of the telephone from its hook for closing the said storage battery in a local circuit with the microphone and the primary of the induction coil, whereby the storage batteries are charged by the central station battery, the interposition of the said retardation coils preventing the diverting of the voice currents.

540,244. ELECTRIC HEATER; E. E. Gold, New York, N. Y. App. filed Jan. 29, 1895. The combination of horizontal coils of resistant wire and vertical insulating supporting plates, having end projections between which the coils are stretched and lateral projections embracing the coils at intervals on opposite sides and constructed to leave air spaces between the plates and free openings at top and bottom for the circulation of air through the coils.

540,264. APPARATUS FOR EXTINGUISHING FIRES; J. G. Loirain, London, England. App. filed Sept. 28, 1893. The combination of a valve and a piece of fusible conducting material inserted as a wedge between two parts of the apparatus and serving to sustain the valve in normal position, a source of electric energy having a circuit, and a circuit closer for the said circuit.

540,305. CLOSED CONDUIT ELECTRIC RAILWAY; M. F. Flynn, Stamford, Conn. App. filed July 28, 1894. The combination of a conduit having supply and return wires therein, a contact rail with a trolley mounted thereon, switches at intervals on the said contact rail adapted to connect with the supply and return wires, and mechanism carried by the trolley to successively close and open the switches to the supply wire.

540,323. ELECTROMAGNETIC WINDING; O. F. Loomis and C. A. Pierce, Bound Brook, N. J. App. filed March 9, 1895. A winding or coil comprising a tape composed of sets of strips of metal arranged end to end, the strips of each set being placed flatly together, said sets being connected together at the overhanging ends and forming smooth lap joints wih each other and wound on edge.

540,325. ELECTRICAL TROLLEY FOR CANAL BOATS; A. C. Mather, Chicago, Ill. App. filed Dec. 1, 1893. A canal boat fitted with a trolley having special arrangements to enable the trolley to swing with the movement of the boat and prevent the said trolley from jumping from the wire.

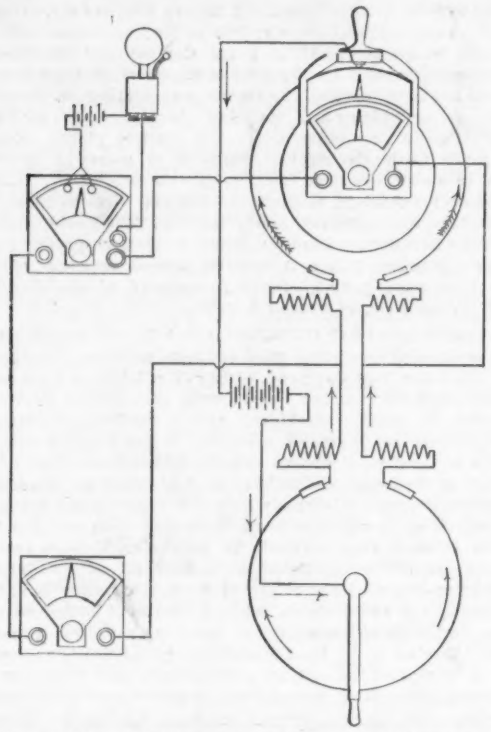
540,333. ELECTRIC ARC LAMP AND CARBON; C. A. Pfluger, Chicago, Ill. App. filed Oct. 13, 1894. The combination of a carbon-feeding mechanism with two electrodes, each elliptical in cross-section and composed of an outer wall of carbon with an inner carbon material, also elliptical and varying in texture from the outer wall.

540,340. TROLLEY POLE WITH LOCKING WHEELS; T. Thomson, Newark, N. J. App. filed Oct. 29, 1894. The combination of a trolley pole, having a suitable arm, trolley wheels set one in advance of the other and adapted to be forced together by a spring to clutch the wire, and a device attached to the trolley leader to release the wheels from the wire.

540,341. ELECTRIC BURGLAR ALARM; J. Tomney, New York, N. Y. App. filed May 2, 1892. The combination of a circuit extending through the premises to be guarded, a signaling instrument, a commutator for bringing into circuit temporarily a predetermined resistance at the time of closing up the guarded premises.

540,351. DYNAMO-ELECTRIC MACHINE; G. De Camp, St. Louis, Mo. App. filed Sept. 24, 1894. The combination of a shaft having bearings between the field magnets, an armature mounted on such shaft on the opposite of the field magnets from the armature and balancing the same, such armature and fly-wheel adapted to revolve parallel to the field magnet coils.

540,352. PAPER REGISTERING MACHINE; T. C. Dexter, Pearl River, N. Y. App. filed Aug. 8, 1894. A paper registering machine having mechanism for shifting the paper laterally, a plurality of electric circuits, electromagnets therein, controlling the action of the said mechanism on the paper, and two separate circuit controllers at opposite sides of the longitudinal path of the paper, adjusted independently of each other.



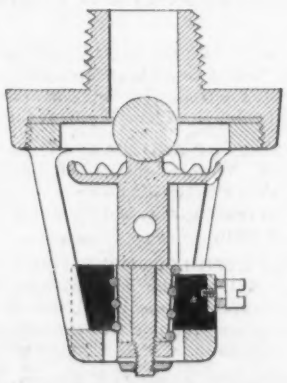
No. 11,498.—Electrical Signaling System.

540,358. ELECTRIC SWITCH; J. O. Heinze, Jr., Lynn, Mass. App. filed Dec. 4, 1894. A switch having one or more blades attached to a shaft, one or more boxes on the shaft for receiving one end of each blade, the shaft having a handle for actuating it, a pin secured to the shaft, and a spring having a seat for receiving the pin and holding the shaft in a fixed position when the blades are in contact with the contact pieces, and means for moving the shaft from engagement with the spring as the blades leave the contact pieces to permit the spring to exert its tension on the shaft and thereby give an increased impetus to it.

540,367. CONTACT POST; R. Segerdahl, Chicago, Ill. App. filed March 29, 1894. A hollow standard of non-conducting material with an adjustable contact passing through it, and a connector which is part of an electric circuit arranged to engage with the contact, so that the same may be introduced in and maintained as a part of the circuit.

540,398. ELECTRIC HEATER; J. E. Meek, Denver, Col. App. filed Feb. 5, 1894. A heating conductor laced with the threads of a flexible non-conducting and non-combustible fabric.

540,404. ELECTRIC ARC LAMP; H. Radcliffe, Milwaukee, Wis. App. filed March 19, 1895. The combination of a carbon holder, a movable arm secured thereto and passing within a casing but insulated therefrom, another carbon holder secured to the casing and insulated from it, and a nut or block secured to the movable arm and a screw rod in engagement with the nut or block.



No. 540,264.—Fire Extinguisher.

40,422. SIGNAL TRANSMITTING APPARATUS AND SYSTEM; H. A. Chase, Boston, Mass. App. filed Sept. 1, 1892. The combination of a box or case provided with a normally closed door, a signal transmitting mechanism therein, arranged and constructed to transmit one kind of signal with the box door open, and another kind when the door is closed, an actuating device for the transmitting mechanism, and means operated by the actuating device to prevent the door being opened or closed while a signal is being transmitted.

540,443. AUTOMATIC SWITCH; A. H. Hobart, Bridgeville, Mass. App. filed Oct. 6, 1894. A switch having a rotating disc, a sector-gear adjustably held on the disc, a gear to be meshed by the sector-gear, and an electric switch composed of a rotating carrier having metal contacts and adapted to be rotated by the gear.

540,456. ELECTRIC MOTOR; F. Pierce, New York, N. Y. App. filed Dec. 3, 1890. The combination of electromagnets, armatures, a rotating shaft, a circuit-breaking arm and contact points, and a spring fastened to one end of the arm and to a rigid support and a block on the armature shaft for vibrating the circuit-breaking arm.

540,463. ELECTRIC GAS LIGHTER; G. W. Shepherd, Philadelphia, Pa. App. filed March 13, 1895. The combination of a screen, a removable crown, a fixed terminal carried by the crown but insulated therefrom and detachably secured to the conductor, and a movable conductor also carried by the crown and made detachable so that the head with the two terminals can be removed from the burner for repairs.

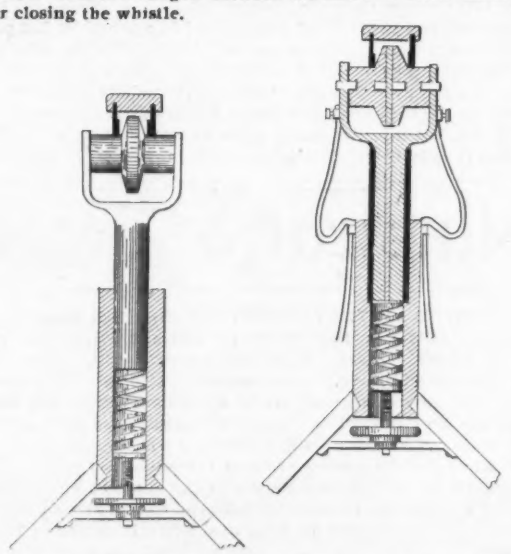
540,477. TELEGRAPHY; C. R. J. Willot, Paris, France. App. filed April 24, 1894. The combination of a transmitting key connected to the cable by two polarized relays, one acting under the influence of positive emissions, and the other acting under the negative emissions, the relays so adjusted that they are only operated by emissions having a greater duration than that corresponding to a dot of the code, and so determine the blank space operating the signals.

540,480. APPARATUS FOR USE WITH ELECTRICALLY ILLUMINATED SIGNS OR ADVERTISEMENTS; E. L. Berry and F. Harrison, London, England. App. filed Nov. 21, 1894. The combination of two or more circuits and a switch provided with contacts arranged to break contact with the brush alternately at opposite edges of the brush.

540,486. TROLLEY FOR ELECTRIC RAILWAYS; T. Euphrat, Darien, Conn. App. filed March 5, 1895. The combination of a fork having an ordinary wheel pivoted in the jaws by the usual trolley wheel pivot and the beak resting on the head of the fork, and the trolley wheel having the grease chamber and the detachable trolley pivot confined by the jaws of the fork when in the working position.

540,487. ICE DETACHING TROLLEY FOR ELECTRIC RAILWAYS; T. Euphrat, Darien, Conn. App. filed March 22, 1895. A trolley wheel having a grooved serrated ice-breaking face in combination with the usual trolley wheel and pole.

540,529. ELECTRICALLY CONTROLLED SPEAKING TUBE; G. Williamson, McKeesport, Penn. App. filed Feb. 18, 1895. A speaking tube provided with a signal box comprising a casing divided into chambers of which one is connected with the main speaking tube, and the second is provided with a mouth-piece, a valve controlling the connection between the first and second chambers, a whistle arranged between the first and third chambers, and a lever for closing the whistle.



No. 540,325.—Electrical Trolley for Canal Boats. One of the Blower Motors.

540,540. UNDERGROUND ELECTRICAL CONDUCTOR AND METHOD OF MANUFACTURING SAME; J. H. Croskey and J. Locke, Pittsburg, Pa. App. filed Jan. 17, 1895. An insulated electric conductor section comprising a wire or wires, a solid mass of pressed glass in which the same is imbedded and a split metallic tube inclosing said glass.

540,557. ELECTRIC REGULATOR; J. McKim, Weir, Kan. App. filed Sept. 12, 1892. An electric regulator consisting of a hollow coil located in an alternating current circuit, electric lamps in said circuit, a core, a switch lever connected to said core in such manner that the movement of the one affects the position of the other, and a contact plate also located in the circuit and in the path of said switch lever, so that when the same is in contact with said plate the circuit is completed, and the movement of the lever in one direction or the other and the consequent movement of the core farther in or out of the coil, either diminishes or increases the brilliancy of the electric lights.

540,500. CONDUIT ELECTRIC RAILWAY SYSTEM; C. M. Allen, San Francisco, Cal. App. filed Oct. 3, 1894. A conduit having a series of contact boxes fixed therein, and at one side of the opening an insulated main conductor, movable plates also within the conduit having shanks extending through the boxes and provided with rollers, a contact bar supported from the car and adapted to travel with it to form contact with the rollers and force the contact plates together as it passes, and means for withdrawing the movable contact from a stationary one.